electronics

radio, sound, communications and industrial applications of electron tubes · · · design, engineering, manufacture

A survey of electron-tube applications

✦

Salaries paid radio engineers

✦

Signal-seeking circuits for superheterodynes

✦

Advances in AC-DC design

✦

Features of the new KYW

Facsimile wire-photo service begins for 3 newspapers from coast to coast. *See p. 9*

McGRAW-HILL PUBLISHING COMPANY, INC.

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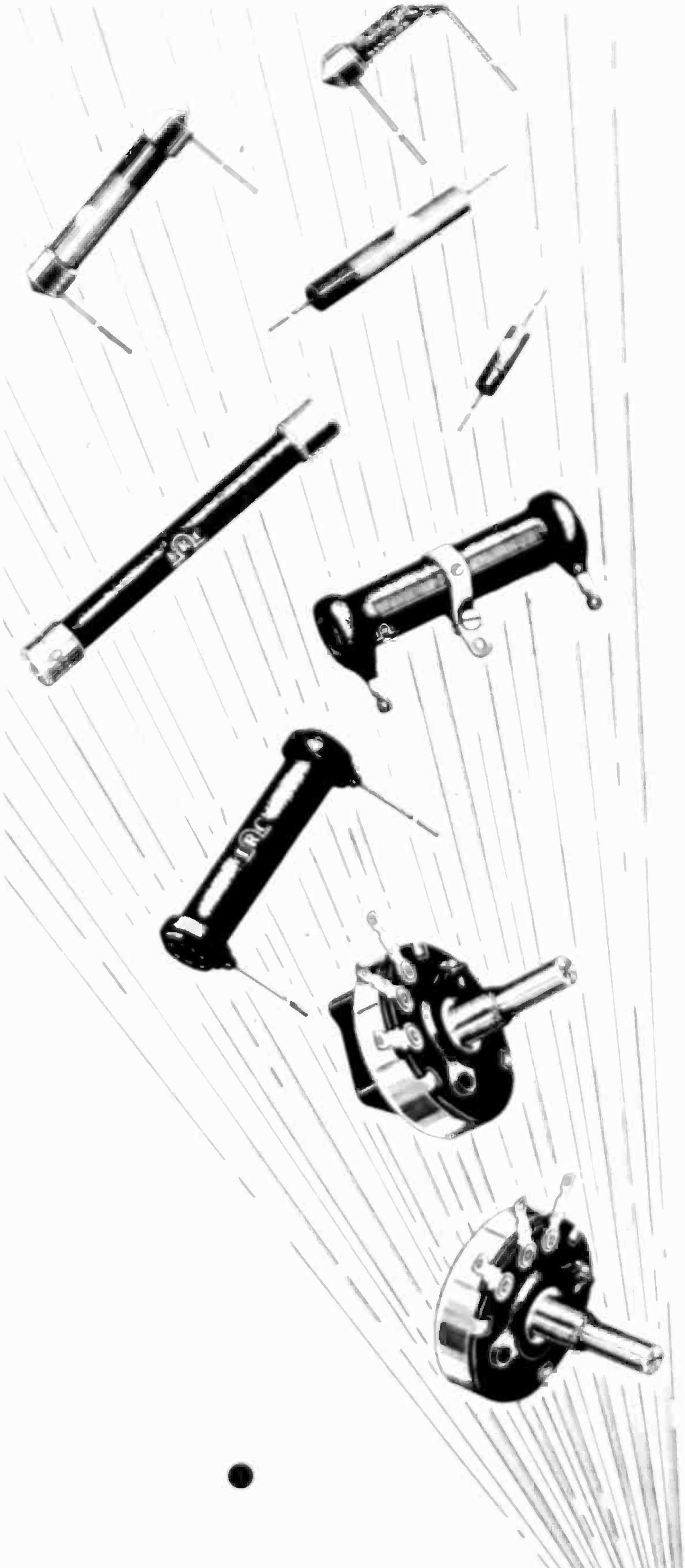
JANUARY 1935



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electronics

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ORESTES H. CALDWELL
Editor
KEITH HENNEY, Managing Editor

HOWARD EHRLICH
Vice-President

H. W. MATEER
Manager

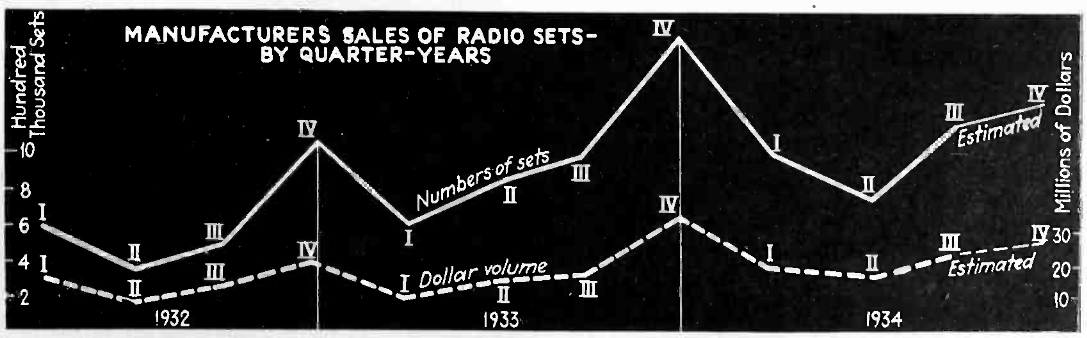
radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

"Taking stock"

JANUARY is usually a time of "taking stock," and so we present on the following pages an enumeration of the principal rôles which the electronic arts now play in communication, entertainment, industry, therapeutics, the sciences, and everyday life.

THE electron tube is scheduled for even more important developments during 1935. Its promising future in the new field of direct-current high-tension power transmission will be described at the New York City AIEE convention this month. Using tubes as rectifiers, power increases of three to ten times can be carried over existing lines and cables. With present losses, transmission distances can be extended five to sevenfold. At the receiving end, any a-c frequency can be picked off the d-c transmission! Already an experimental line carrying up to 3,000 kw. has been operated successfully, and its extraordinary performance on short-circuit and other troubles demonstrated to power-company officials. Another revolutionary development to be revealed at the same meeting, will be the thyratron-tube commutated motor of Dr. Alexanderson. A 400-hp. motor unit has been arranged for tube commutation, and has demonstrated its easy starting characteristics when thrown directly across the line!

MEANWHILE radio production has reached a high, second only to 1929 in numbers of sets. The chart below shows the output by quarterly periods, with the last quarter of 1934 estimated. Had this last quarter paralleled the last quarters of preceding years, the line would have gone off the chart, and the year's production exceeded five million sets. Conservative opinion indicates that the last quarter will only slightly exceed the third quarter, bringing the year's output to around 4,700,000 sets.



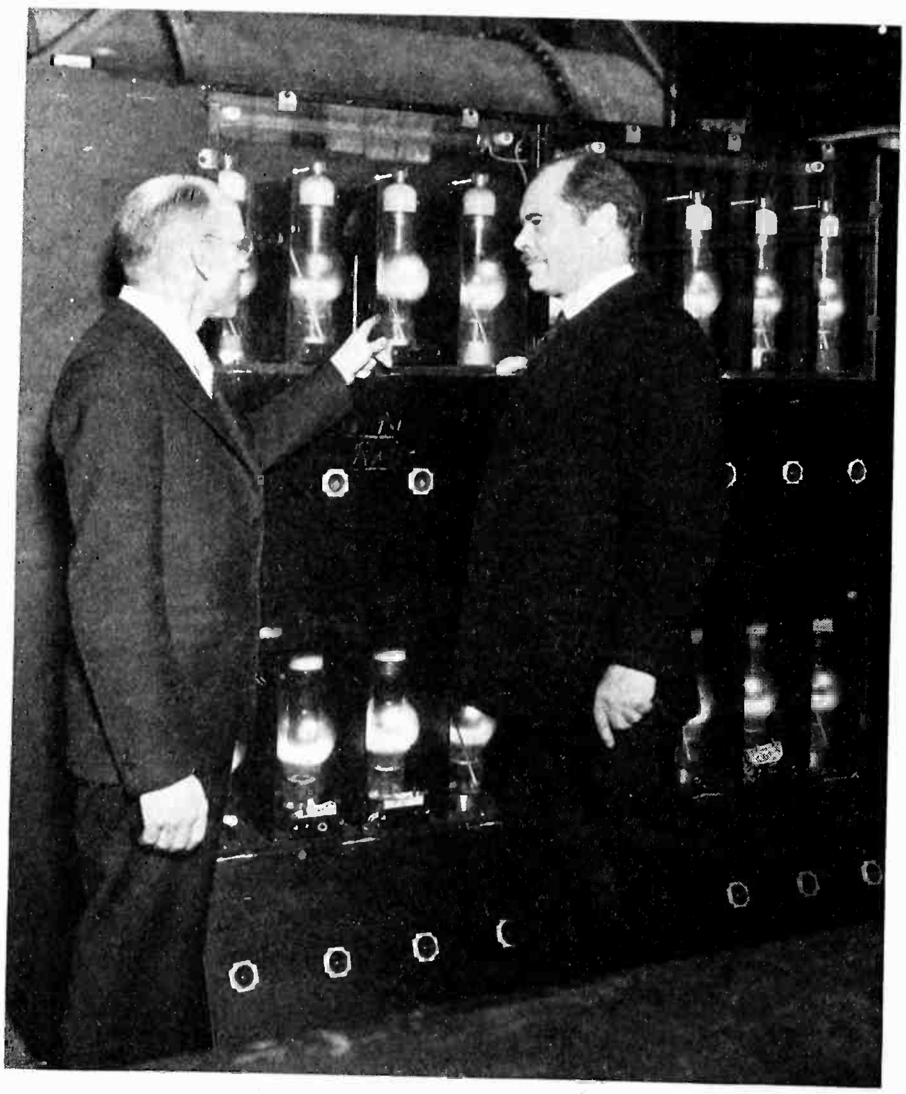
+ + APPLICATIONS OF

▼ Only by a rapid survey of existing applications for electron tubes can one gage the growth in importance of these devices, old to communication, new to industry. This list has been compiled from several sources and contains workable and working applications, with emphasis on the non-communication uses of rectifiers, amplifiers, phototubes, grid-glow tubes and thyratrons, cathode-ray tubes etc. In the listing these are indicated by Amp., for amplifier; PE for photoelectric; Rect., for rectifier; Osc., for oscillator, etc.

Counting, Measuring

Production lines (motors, automobiles, radios, refrigerators, etc.) (PE)
Traffic in tunnels, on bridges, etc. (PE) (Amp.)
People passing, or entering (theaters, etc.) (PE)
Animals, livestock, etc. in stock-yard pens (PE)
Recording beats of master clock (PE)
Printing and engraving (PE)
Tabulating statistics, quantities (PE)
Measuring lamp candlepower (PE)
Timing races (PE)
Integrating irregular areas by measuring light transmitted (PE)
Astronomical measurements (PE)
Color measurement (PE)
Turbidity measurement (PE)
Projectile velocities (PE)
Calipering steel balls (PE)
Control of sprays in lumber painting (PE)
Boiler-gauge level alarms (PE)
Automatic sheet-catchers in rolling mills (PE)
Counting of printed items on cards, totalizing and analyzing (PE)
Life tests of floor material (PE)
Automatic inspection of razor blades (PE)
Weighing machines (PE)
Measuring transmission of glass, goggles, etc. (PE)
High-speed counting (Thyratron)
Noise surveys (Amp.)
Vibration measurement (Amp.)
Comparing auto tire noises (Amp.)
Measuring luster in textiles (PE)
Testing fuses (Cathode rays)

THYRATRON-COMMUTATED MOTOR



A. H. Mittag and E. F. W. Alexanderson, co-authors of an A. I. E. E. paper on the "Thyratron" motor, in front of part of the motor's Thyratron equipment

Industrial

Reversing rolls in steel mill (PE)
Motor speed control (Amp.)
Removal of soaking-pit covers (PE)
Control of cut-off saws (PE)
Calibration of watt-hour meters (PE)
Calibration of frequency meters (PE)
Control of cathode coating machine (Amp.)
Regulation of clocks (Grid-glow)
Furnace temperature control (PE)
Limit switch control for motor travel (PE)
Control of thickness of sinter beds (PE)
Flue gas control (PE)
Elevator door guards (PE)
Filament winding machine control (Grid-glow)
Testing welds (x-rays) (Amp.)
Humidity control (Amp.) (PE)
Induction furnace (Osc.)
Indicators in smoke stacks (PE)
Detecting cracks and flaws (PE) (Osc.)
Opening doors for trucks (PE)
Hydrogen ion concentration control (PE)
Wire diameter recording (Osc.)
Metal flotation control (PE)
Moisture regulation (Osc.)
Mine ventilation door operation (PE)
Photographic printing exposure (PE)
Oil and ore prospecting (Osc.) (Amp.)
Package machine register control (PE)
Welding current and timing control (Rect.)
Operating valves, switches (PE)
Safety protection of machines (PE)
Analysis of card records (PE)
Sludge level control in sewage plant (PE)
Alarm for smoke, water hardness, etc. (PE)
Turning threads on pipe, conduit (PE)
Paper break detection, manufacture, presses (PE)
Bag piling by conveyors (PE)
Feed to rubber-cutting table (PE)
Automatic weighing of batches (PE)
Pre-selective conveyor system (PE)
Automatic folding, registering (PE)
Synchronizing conveyors (PE) (Thyratron)
Automatic titration (PE)
Leveling elevators (PE) (Osc.)
Correcting for elevator cable stretch (PE)
Flagging tote pans on conveyors (PE)
Inspection of battery-caps for vents (PE)
Pulp control in paper mill (PE)

Detecting borers in timber (Amp.)
Control of enamel thickness of wires (PE)
Viscosity measurement and control (Amp.)
Speed regulation of motors (Amp.) (Rect.)
Voltage regulation (Amp.) (Rect.)
Wire drawing control (Thyratron)
Gyroscope stabilization (Thyratron)
Thickness of rubber sheet control (Osc.)
Checking speed and synchronism (Stroboscope)
Coating sandpaper (Rect.)
Geophysical prospecting (Osc.) (Amp.)
Detecting leaks in water mains (Amp.)
Testing for surface faults in shafts, etc., by use of phonograph needle (Amp.)

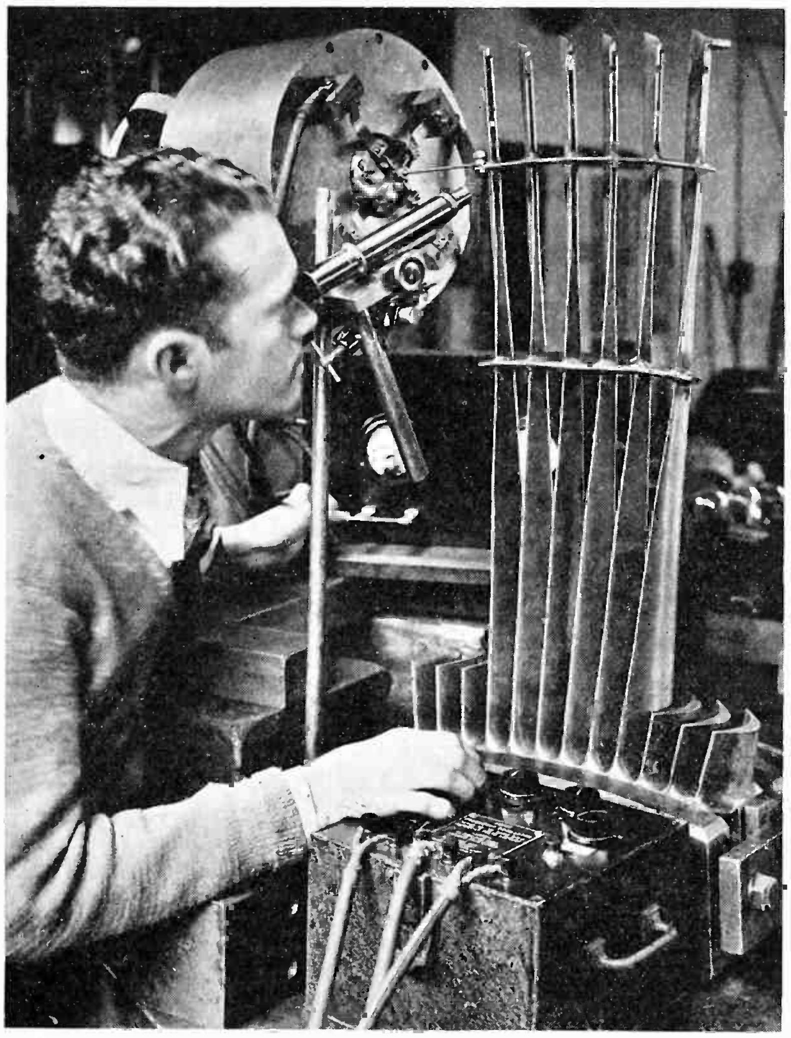
Traffic Applications

Railroad signals (PE) (Amp.) (Osc.)
Street traffic lights (PE)
Elevator leveling (PE) (Osc.)
Elevator-door safety control (PE)
Routing mail-bags and letters (PE)
Counting street traffic (PE) (Amp.)
Checking up bridge toll collections (PE) (Amp.)
Checking up theater patronage (PE)
Detecting dangerous gas in tunnels (PE)
Lighting air-beacons and air-fields (PE)
Controlling wind indicators from pilot-vanes (PE) (Amp.)
Detecting automobile speeding, by two photocells in roadway (PE)
Parking lights on automobiles lighted at dusk (PE)
Head lamps dimmed at approach of another car (PE)
Head-room alarms for tunnel and bridge approaches (PE)
Adjoining street signs and displays controlled by traffic lights (PE)
Swing-bridge pin-lock safety indicator (PE)
Identifying and recording freight-car numbers (PE)
Checking auto crank-case oil at service stations (PE)
Adjusting illumination in vehicular tunnels (PE)
Calling gas-station attendant when car stops (PE)
Sextant for locating sun's position obscured by clouds (PE)
Railway track inspection (Amp.) (Osc.)
Analysis of road traffic (PE)
Aiding docking of vessels (Amp.)
Announcing loud speakers in bus and train depots (Amp.)
Calling systems in stores (Amp.)
Directing traffic from police cars (Amp.)
Locating mobile bodies in water, fog, etc. (Amp.)

Grading (PE)

Cigars
Tile
Beans, vegetables
Detecting missing labels
Inspecting tin-plate

TESTS ON TURBINE BLADES



The operator of this vibration testing device, employing electron tubes, places various frequencies upon the blades of the turbine and observes their vibration through a microscope

Calipering small parts
Color comparison
Adjusting auto headlights
Detecting flaws in products
Sorting checks and bills
Matching false teeth
Oil and paint
Sorting resistors (Amp.) (PE)
Rejection of non-sharp razor blades

Scientific Instruments

Bridge balance indicator (Amp.) (PE)
Camera shutter tests (PE)
Cosmic ray counter (Amp.)
Curve plotter (PE)
Dilatometer (Osc.)
Photometry of lamps (PE)
Magnetic flux meters (PE)
Follow-up mechanism (PE)
Wave form analysis (Cathode ray)
Impact meter (Grid-glow)
Micrometers (Osc.) (Amp.) (Grid-glow)
Continuous calipering (Osc.)
Protection to meters (Amp.)
Pressure indicator (Amp.)
Vacuum tube wattmeters (Amp.)
Counting electrons (Amp.)
Medical diagnosis (Heart) (Amp.)
Hysteresiograph (Cathode ray)
Regulating watch and clocks (Amp.)
Impulse counter (Amp.)
Frequency control in astronomical observatory (Amp.) (Osc.)
Pyrometers, remote (Amp.)
Blood analysis (PE)
Criminal detection (Amp.)
Titration of chemicals (PE)
Measuring viscosity (PE)
Measuring film density (PE)
Temperature control (PE) (Amp.)
Testing oils (PE)
Measuring total light flux (PE)
Indicating wind velocity (PE)
Color analyzers (PE)
Color matchers (PE)
Light-intensity meters (PE)
Exposure meters (PE)
Turbidity meters (PE)
Combustion indicator (PE)
Master-clock control of secondary clocks (PE) (Grid-glow)
Remote indicating meters (Amp.) (PE)
Indicating shaft rotation (PE)
Meridian passage of stars (PE)
Recording variable stars (PE)
Guiding telescope on star (PE)
Detecting faint spectral lines (PE)
Measure instant of eclipse (PE)
Measure width of eclipse path (PE)

Measuring high rotational speeds by light producing tones (PE)
Sighting guns for automatic firing (PE)
Current detectors and amplifiers (Amp.) (PE)
Spectrum analysis (PE)
Stroboscope (Grid-glow)

Medical Applications

"Radio knife" (Osc.)
Musical anesthetic (Amp.)
Microphone and speaker in operating rooms (Amp.)
Artificial fever machines (Osc.)
Superstethoscopes for listening to internal organs (Amp.)
Electric cardiograph (Amp.) (Cathode ray)
Measuring and treating deafness (Amp.)
Blood analysis (PE)
Diagnosis of broken bones, etc. (X-ray)
Heartbeat amplifier (Amp.)

Light Measurement and Control

School-room lighting (PE)
Shop and factory lighting (PE)
Electric signs (PE)
Automatic flasher (Grid-glow)
Automatic headlight dimmer (PE)
Flood lighting and decorative effects (PE) (Rect.)
Store lighting (PE)
Office lighting (PE)
Street lighting circuits (PE)
Air ports, aviation beacons (PE)
Light-houses, range lights, markers (PE)
Store and window lights, turned on at approach of passers-by or patrolman (PE)
Parking lights on autos, automatically lighted at dusk (PE)
Riding lights on moored vessels, automatically lighted (PE)
Photographic printing and enlarging (PE)
Headlight inspection (PE)

Visual Reproduction

"Facsimile" transmission of photographs, maps, newspapers, etc. (PE)
Television transmission (PE)
Half-tone and line-cut production (PE)
Three-color plate engravings (PE)
Enabling blind to read ordinary print (PE)
Automatic curtains framing movie screen (PE)
Automatic photographing of sneak-thieves, burglars, etc. (PE)

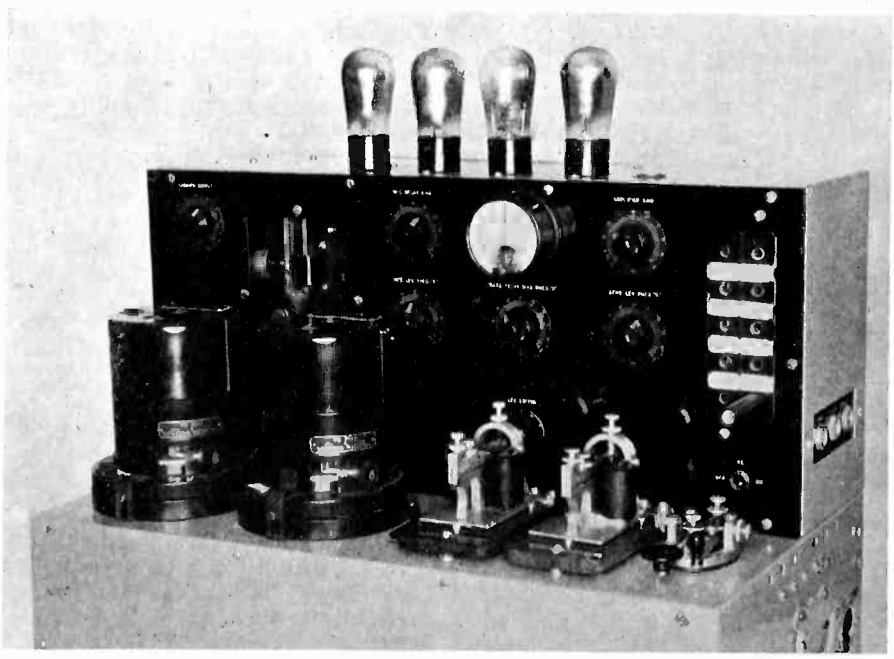
Sound Production

Phonograph recording (PE)
Sound-picture recording (PE)
Sound-picture reproduction (PE)
Light-beam transmission (PE)
Light siren (PE)
Photo-electric organ (PE)
The "talking book" for blind (PE) (Amp.)
Talking wills (Amp.) (PE)
Talking "rogue's gallery" (Amp.) (PE)
Automatic merchandiser says "thank you" when purchase is made (PE)

Electric Power Systems

Synchronizing power circuits (Thyratron) (Amp.)
Controlling alternator frequency (Amp)
Detecting flash-overs on rotary converters (PE)
Reporting circuit-breaker operation (PE)

CARRIER TELEGRAPH BOOSTER



A portable single-channel duplex carrier telegraph terminal set as used by Western Union for "hot-spot" and emergency circuits utilized when sudden demands arise taxing the facilities of a single pair of wires

ELEVATOR PROTECTION

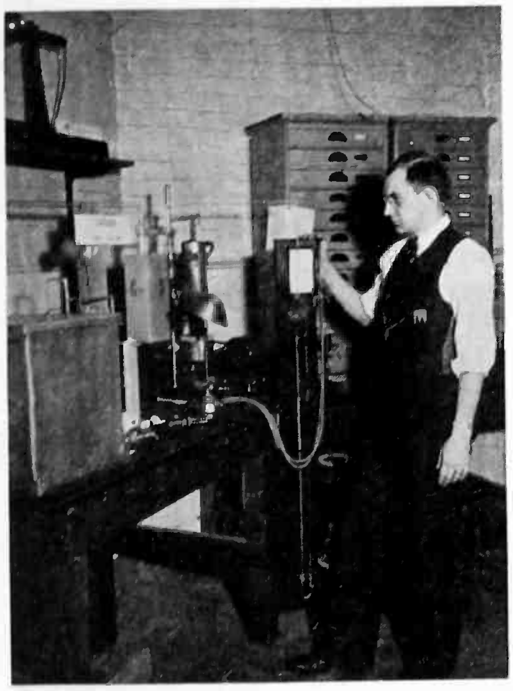
Phototubes protect occupant of push-button elevator against premature closing of doors in remodeled New York apartment

Controlling street-lighting circuits (PE)
Safeguarding high-tension buses (PE)
Bus flash-over protection (PE)
Controlling isolated plant operation from predrawn chart (PE)
Telemetering (Amp.) (Osc.)
Circuit breakers (Thyratron)
Automatic voltage control (Amp.)
Lightning arresters (Amp.)
Vacuum tube commutator (Thyratron)
Frequency indicators (Amp.)
Rectifiers for street railway power (Rect.)
Operating d-c motors from a-c source (Amp.)
Static discharger on antennas (PE)

Printing, Publishing, Etc.

Speed control on fast presses (Rect.)
Automatic machine setting of type, from typewritten copy (PE)
Half-tones made by photo-electric scanning (PE)
Control of register on web presses (PE)
Control of accurate trimming (PE)
Accurate cutoffs for labels, bags, etc. (PE)
Automatic stops for presses, preventing paper breaks (PE)
Adjusting density of printing (PE)
Counting of sheets and forms in binderies (PE)
Control of paper thickness and moisture during manufacture (PE)
Matching the colors of inks and papers (PE)
Controlling uniformity of color during printing runs (PE)
Providing permanent unfading color records (PE)
Measuring glare and opacity of paper (PE)

MINERALS IDENTIFIED BY X-RAYS



Apparatus used by geologists in the University of Wisconsin for crystallographic study of minerals

Safety-first devices around presses (PE)
Detecting and correcting press vibrations (PE)
Automatic door-openers for binderies, shipping rooms, etc. (PE)
Mailing list analysers and sorters (PE)
Automatic light-intensity control in printing and engraving plants (PE)
Control of paraffine-vapor spray for preventing offset (PE)
Grading of photographic negatives in gravure process (PE)
Bleaching-process control (PE)
Reclaiming of "white water," control of digester, etc. (PE)
Making engravings from photos by wire (PE)

Safety Uses (PE)

Protection of punch-presses and other dangerous machines
Protection of elevator doors, preventing car from starting unless all passengers are clear of threshold
Transmission of weather maps to ships at sea
Detection of ice-bergs, ships, etc. through fog
Safety doors in mines
Remote control of dangerous processes
Protection of jails, penitentiaries, etc.
Protection of electrical machinery
Traffic-signal operation
Auto speeding detectors
Street-lighting control
Burglar and kidnapping alarms
Talking "rogues' gallery" (sound pictures)
Detection of dangerous gases in tunnels
Hold-up protection, banks, etc. (closing of safety steel shutters)
Fire alarms, smoke alarms
Safety protection of oil-burners

Airway beacons
Lighthouses and marker lamps
Sewage treatment control
Gunfire control

Home Possibilities

Controlling uniform illumination (PE)
Monitoring oil-burner pilot flame, to operate safety valve (PE)
Garage and kitchen door openers (PE)
Alarms against burglars and trespassers (PE) (Osc.)
Flood-lighting control (PE)
Night-lights around house automatically turned on and off (PE)
Automatic opening of refrigerator door (PE)
Photographic exposure meter (PE)
Electrical musical instruments (PE) (Osc.) (Amp.)
Window raising and closing mechanism (PE)
Aids for invalids, the crippled, etc. (PE) (Amp.)
Kidnapping alarms for nurseries (PE) (Amp.)

Communication

Radio broadcasting
Point-to-point
Ship-to-shore
Ground-to-aircraft
Police radio
Transoceanic telephone and telegraph
Photograph and facsimile transmission
Communication with trains
Supersonic; underwater
Course and range finding
Aids to navigation

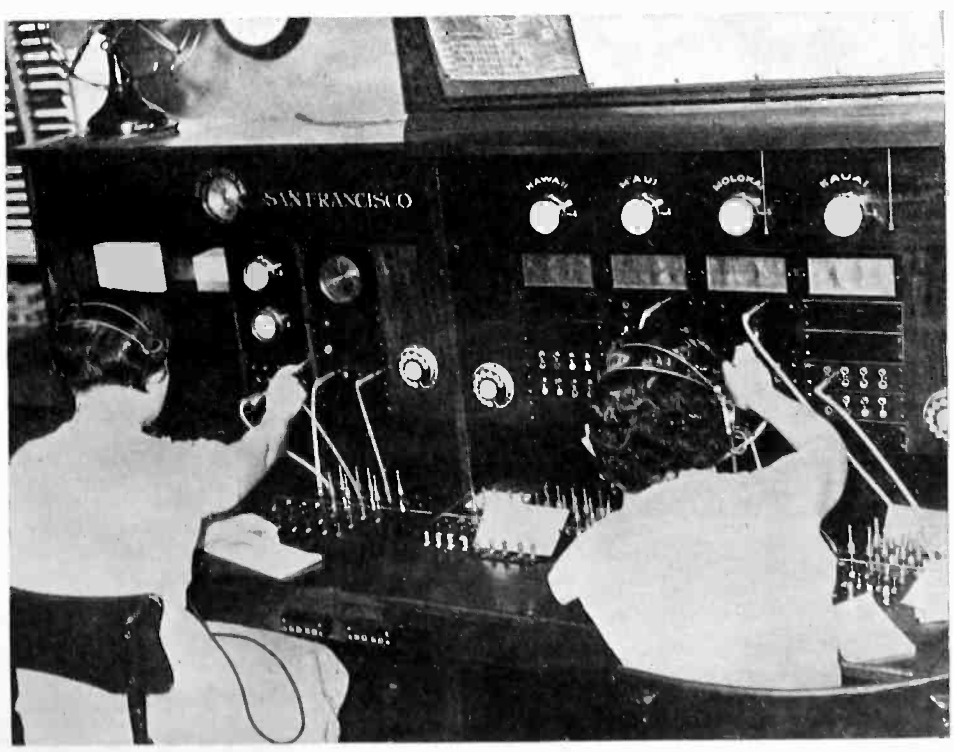
Sports

Timing races (PE)
Foul-line for bowling alleys (PE)
Timing of golf-club swings (PE)
The photo-electric shooting gallery (Light-beam gun; photocell as target) (PE)

Food and Chemical Processes

Control of level in tanks and bins (PE)
Drinking fountain control (PE)
Turbidity control in water systems (PE)
Cold-room door operation (PE)
Automatic control of heat-treating (PE)
Opening doors for animals (dairy, stables, etc.) (PE)
Tooth-paste filling machine (PE)
Bottle fillers (PE)
Metal-tube inspection (PE)
Control of coffee roasters (PE)
Candling eggs (PE)
Moth control in orchards (PE)
Synchronizing of two conveyors (PE)
Sorting raisins at 1,000 per minute (PE)
Sorting lemons, beans, etc. (PE)
Eliminating green peaches from cannery stock (PE)
Sorting cigars (PE)
Testing oil (PE)
Control of acidity, alkalinity (PE)
Sludge level indicator for sewage-disposal plant (PE)
Sterilizing foods (Osc.)
Killing insects on plants (Osc.)

HAWAII'S INTER-ISLAND RADIO TELEPHONE



Operators at the telephone channels which connect Honolulu with the mainland and with the other islands in the Hawaii group. High frequency radio is used in place of cable to connect the widely scattered telephone centers with the Honolulu exchange and the United States

KYW

Directional aerial, complete a-c operation, nitrogen filled condensers among features of new station

When KYW began broadcasting from its new location near Philadelphia, on December 10th, it became the first completely a-c operated high power broadcast station in the country. The new transmitter, designed to deliver 50 kw. of power to its antenna, is operated at a reduced power of 10 kw., but the entire installation is capable of handling full capacity as soon as permission to use it is obtained.

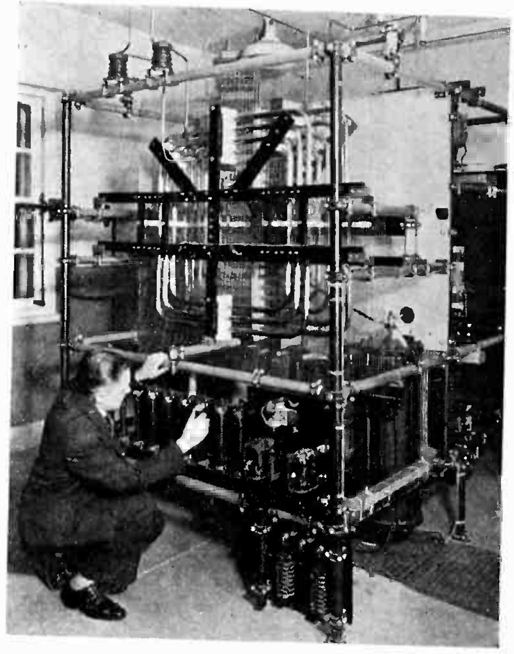
The station has been designed with two ends in view: to reduce the bulk of the transmitting equipment, and to achieve low operating costs consistent with high quality transmission. The size of the station has been reduced materially in several ways. No rotating machinery is used; the entire station including the filaments of the high power radio frequency amplifying tubes, is operated on alternating current. The high voltage rectifier unit is of a new design, of much smaller dimensions than the usual power rectifier used for broadcast stations. Nitrogen filled condensers have been used in the tank circuits of the power amplifiers, with a considerable saving of space.

The power requirements have been lowered by the use of high level class B modulation, and class C power amplification. The class B modulator consumes power only in proportion to the degree of modulation; thus while the modulator is capable of delivering 40 kilowatts of audio power, for 100 per cent modulation, it consumes very little power during periods of no modulation. At 100 per cent modulation, the entire power requirements for the station total 277 kw. When not modulated the station requires only 114 kw.

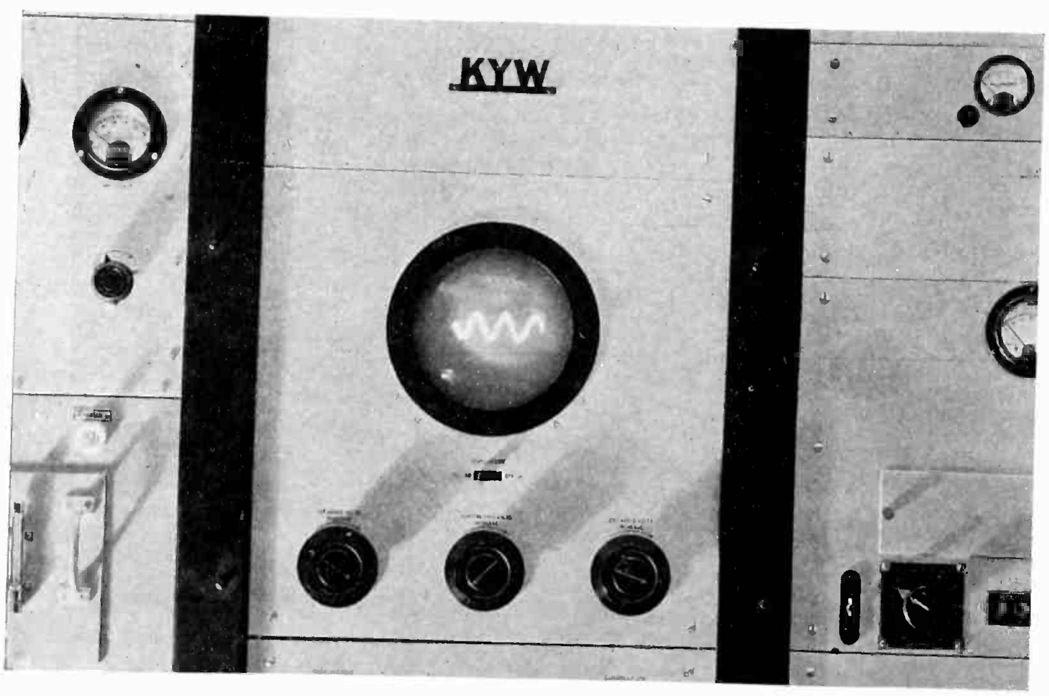
Further conservation of power is made possible by the use of a directional antenna. A four-element array, consisting of four 200-foot vertical radiators, provides the directional pattern (see front cover, *Electronics*, December, 1934) whose maximum signal lies on the line connecting Philadelphia and Allentown, which cities receive the bulk of the radiated power. The minimum signal (only one per cent as strong as the maximum) is directed at New York City. Possible interference with station WHN in New York, assigned to a frequency only 10 kc. from KYW, is thereby made very unlikely.

The radiators are made of telescopic steel tubing to which a No. 4 copper braid has been riveted along the entire 200 foot length. The use of four radiators, rather than the two usually used for directional purposes, is aimed at a reduction of the sky-wave, with a concentration of the power in the primary service area as the result, and with the possibility of interference with distant stations greatly reduced. The radiators themselves are mounted on wooden cradles or bases, each 45 feet high, making the total tower height 245 feet. Suspended from these bases and strung between them is a network of copper wire, 55 thousand feet in length, which is used to improve the ground system of the transmitter.

The directional character of the antenna depends upon the proper phase and amplitude relations being maintained at each radiator. Inside the station a special panel, containing a cathode ray oscilloscope, is provided so that these relations may be checked. Each antenna section is separately tuned by a special coupling house at the base of each radiator. The tuning of these coupling circuits is remotely controlled from the station building, by the use of motor driven condensers. The operator can thus visually check the directional qualities of the antenna system and correct them if necessary without leaving the station building.



Static shield used to reduce harmonic radiation. One of the nitrogen-filled condensers is at the lower right



A close-up view of the oscilloscope monitor, mounted in the radio frequency control board. Note the aluminum panel

In the interest of reducing harmonic radiation, a specially designed static shield has been placed between the primary and secondary of the main antenna coupling transformer. This shield, shown in the illustration, is composed of many rod-like conductors and is carefully grounded. In addition balanced condensers are used to reduce harmonic radiation.

The tank condensers in the radio frequency amplifying circuits are of radically new design. The entire condenser is mounted in a gas tight housing which is filled with pure nitrogen

Two rectifier panels. The left hand section provides 12,000 volts at 17 amperes

at high pressure. A given capacity can thus be built into a much smaller space without danger of arc-overs; in fact the nitrogen filled condensers can stand much greater voltage overloads than the more conventional air-dielectric type.

The frequency of the output of the transmitter is controlled by the conventional quartz plate, temperature regulated. The accuracy of the unit used is 0.005 per cent or better, corresponding to a deviation of only five cycles on each side of the assigned frequency of 1020 kc. Frequency monitoring equipment is supplied by the use of another highly stabilized quartz plate oscillator whose output is mixed with the output of the station itself. The resulting beat notes are rectified and applied directly to an indicating meter having a center-zero pointer. This meter is calibrated directly in cycles, and shows both the magnitude and sign of the frequency drift.

The modulation capacity of the transmitter is 100 per cent, as is usual in high power stations. But to operate the transmitter near 100 per cent modulation without over-modulating, i. e., to achieve the maximum efficiency without introducing distortion, some sort of over-modulation indicator is required. This is provided in the station, a neon glow lamp being flashed every time the modulation exceeds a predetermined percentage. This lamp is operated from the output of a rectifier and amplifier which receives a part of the r-f output of the station itself. Although volume controls are not provided in the station building itself, on the theory that the studio should have complete control of the program level, if the station operator sees that over-modulation is occurring he can telephone the control operator at the studio warning him that the audio level is too high.

The audio frequency range provided by the modulation equipment is 30 to 8,000 cycles per second, flat within plus or minus 2 db. Besides the over-modulation indicator, a modulation oscilloscope of the cathode ray type is also provided, which can be connected to any of the various audio and radio circuits for checking distortion and other modulation characteristics. There is also provided an audio oscillator and calibrated attenuator for checking the audio frequency characteristics of the speech and modulation equipment, and for testing the lines from the studio.

In the entire station there are only two batteries, and neither of these is concerned with the transmission itself. The sweep circuit on the cathode ray monitor has a small storage battery and 180 volts of dry battery, but other than this tube rectifiers are used whenever d-c is required. The tubes of the main r-f amplifiers are fed with a-c. Under ordinary conditions such a procedure would introduce a very noticeable hum modulation to the carrier. But by the use of a "magnetron suppressor" this hum is counterbalanced. The suppressor introduces into the plate circuits of the amplifiers a current of the proper phase, waveshape, and amplitude to exactly counterbalance the hum modulation in the plate circuit due to the a-c on the filaments. In this way a substantially hum-free carrier comparable in every way to that available from amplifiers using generator-fed filaments is obtained.

Considerable attention has been paid to the appearance of the station and its eye-appeal is readily apparent. The transmitter building itself is of an attractive Dutch Colonial style with landscaped lawns, while the interior of the station has been fitted with aluminum panels trimmed in black. The operating room, separated from the transmitting equipment room, thus presents a well finished appearance.

THE NEW KYW

Antenna:

Type: Four-element directional array.
Radiators: Four, vertical, 200 feet high.
Signal ratio: 100 to 1. Maximum signal to Philadelphia. Minimum to New York.
Phasing control: Oscilloscope monitor and remote control tuning.

Radio Frequency Carrier:

Frequency: 1020 kc.
Power: 50 kw.
Present operating power: 10 kw.
Frequency stability: Within .005 per cent, i.e. plus or minus 5 cycles.
Frequency monitoring: Heterodyne with auxiliary crystal.
Tubes used: 8—207's.

Modulation:

Capacity: 100 per cent.
Fidelity: 30 to 8,000 cycles plus or minus 2 db.
Class: High level, class B.
Tubes: 4—848's.
Monitoring: Over-modulation indicator. Cathode-ray oscilloscope.

Power supply:

A-c supply: 3 phase, 4150 volts, 60 cycles. Input power, 100% modulation, 277 kw.
Tube filaments: a-c operated.
Rectifier tubes: 6—857's.
Rectifier output: 12,000 volts, 17 amperes.

Special features:

Nitrogen-filled r-f tank condensers. Entirely a-c operated.
Magnetron suppressor for clearing carrier noise. Static shield for harmonic reduction.

Salaries paid radio set engineers

IN AN industry like radio, based completely upon a complex technique, it is worth while occasionally to estimate the cost of engineering and, as a by-product, to determine the payment made to the engineers who make possible that industry. To that end, and as a portion of an annual summary of the radio industry given before the December meeting of the Institute of Radio Engineers, in New York, a questionnaire was submitted to a number of engineers, some of whom were actually employed in radio set plants and therefore conversant with salaries paid, and some of whom were in other branches of the radio industry and therefore probably not in possession of facts on the matter of engineering salaries and costs.

For sake of argument the radio plants were divided into three groups, those making 10,000 sets a year or less, those making between this number and 100,000 per year, and finally those larger manufacturers who make in excess of this number; the manufacturers in fact who do the larger share of the annual business. At the close of the year 1934 it is estimated that there were 115 set plants in operation divided into these three groups.

Those questioned were asked to estimate the number of each grade of engineer employed in plants of these three sizes, and finally to put down a figure representing the number of years the engineers had been in their chosen industry. For the latter data, figures of 10, 7, 6, 3, 2 for the various engineering grades are indicated.

These figures must be considered as preliminary only. Correspondence on the entire subject of salaries, working conditions, the methods used here at arriving at the figures given, etc., is invited by the editors of *Electronics*. It is hoped that as a result of such an information-sharing plan, a set of data may be prepared which is truly representative of the industry at large.

It must be admitted that various sources of error exist in such a compilation. Definitions of what constitutes a senior or junior engineer differ—it is inferred here that a senior engineer is one who has a number of juniors and laboratory assistants under him. Some laboratory assistants and junior engineers are part-time draftsmen. Often in the group making the fewest number of units per year the engineer does not have a full-time 12-month job. One of the most serious abuses practiced by the industry is to keep an engineer only long enough to get a line of sets designed and in production and then to let him go. Thus, the annual salaries in the smaller-sized plants may be appreciably lower than given here.

Using, however, the data secured indicates that there are approximately 1,000 jobs available for men rated as "radio engineers" and presumably of the caliber to progress through the grade of junior engineer to the jobs of greater responsibility and higher pay.

This number of course does not include radio engineers employed in plants making tubes and other components entering into the annual production of some 4,000,000 radio receivers. If the figure of $3,788,100 is reasonable as the total salary bill for the year it indicates that somewhat less than $1 per set for engineering salaries is spent in a typical year like 1934 when the number of radio sets will probably amount to 4,700,000.

Several comments are available on the data collected by this preliminary survey. One chief engineer spoke of the generosity of the larger set manufacturers in providing junior engineers. It seemed remarkable to him that as many as 30 or more engineers would be employed in a radio plant—although it is known that several of the larger plants have as many as 100 or more engineers.

Another engineer was glad to note that in the higher brackets the figures were lower than hearsay! In this connection it is fair to point out that there are several engineering positions in the radio set industry that pay as much as $25,000 annually, not counting bonuses.

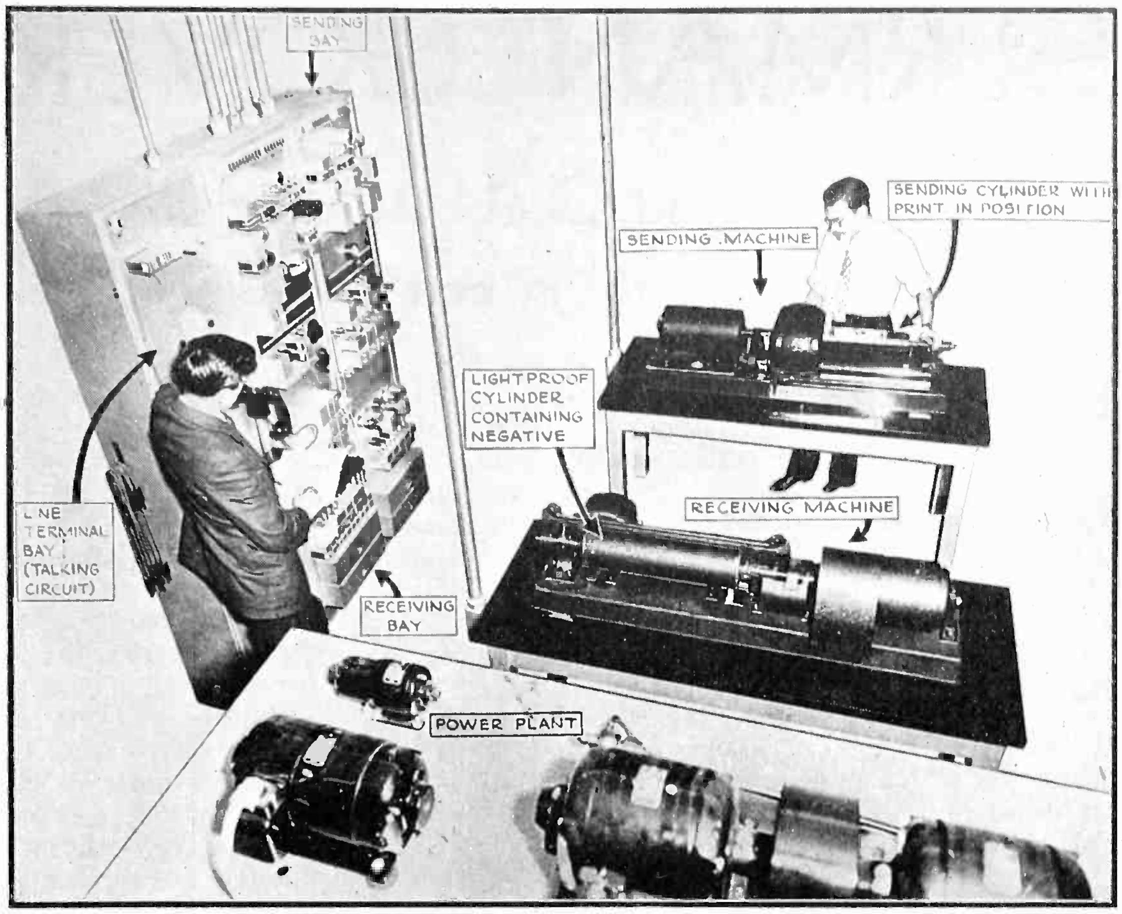
Still another engineer tackled the problem of engineering salary cost in a truly engineering fashion. Comparing radio development expenses with those in other industries he states: "I suspect that the development engineering expenses are about proportional to the dollar value of the industry. On this basis, it seems likely that the salaries for the key men and the number of key men required would both increase proportionally to the square root of the dollar value of the industry."

RADIO SET ENGINEERS' SALARIES

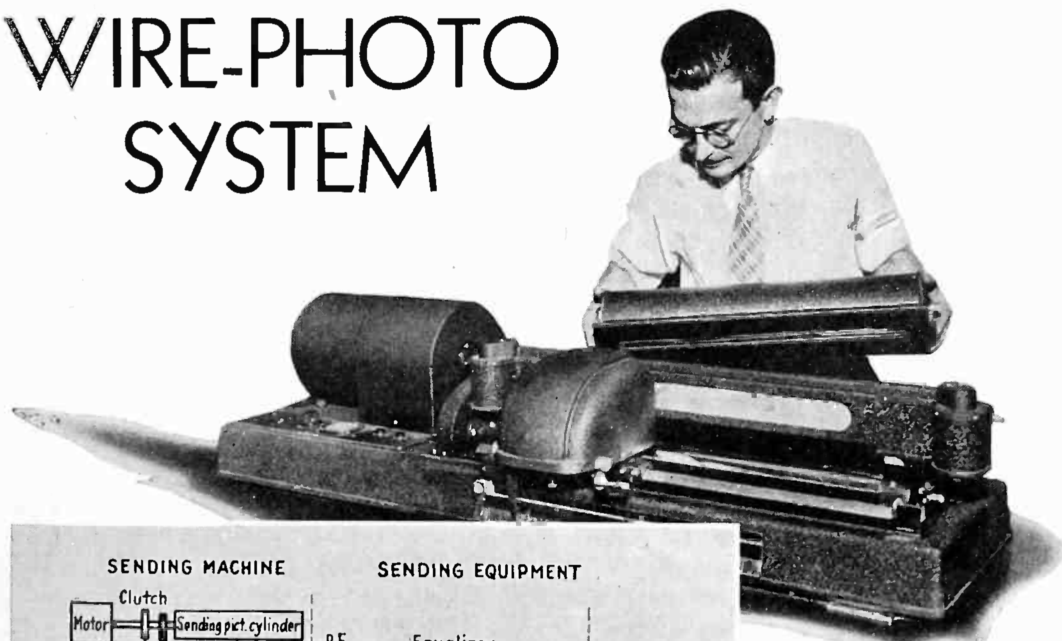
	Plants Making 10,000 Sets Per Year—35		10,000 to 100,000 Sets Per Year—70		100,000 Sets and Up Per Year—10		Total Plants 115	
Title	Annual Salary	No. Per Plant	Annual Salary	No. Per Plant	Annual Salary	No. Per Plant	Total Jobs	Total Pay-Roll
Chief Eng.	$3,860	1	$5,650	1	$7,150	1	115	$612,000
Dept. Head	....	0	4,200	1	4,850	4	110	484,000
Senior......	2,780	1	3,260	3	3,300	7	315	1,012,600
Junior.......	2,160	1	2,380	4	2,470	8	395	938,500
Lab. Ass't.	1,300	2	1,350	5	1,480	12	540	741,000
Annual Engineering Payroll ..	$11,600		$35,860		$87,170			$3,788,100

As a companion study, an attempt was made to obtain similar data in industries other than radio. A most comprehensive study of the salaries paid mechanical engineers was made by the A.S.M.E., as of 1930, and published in *Mechanical Engineering* in September, 1931. Based on replies from 50 per cent of the membership of this society, the median salaries of mechanical engineers in 1930 varied from $2,000 for a man 23-24 years old and out of college 1-2 years, to $5,000 for men approximately 15 years out of school and about 37 years old. A straight line connects these two points. The curve then flattens off until at an age of 58 (35 years out of college) the salary is $7,500 per year. Then the curve slumps off a bit, so that at the age of 60 the engineer's salary was of the order of $7,000. Of course there were many salaries much in excess of this figure, going as high as $25,000 per year, as in the radio industry. The *median* figures noted were obtained by putting down in order returns, starting at the highest and ending at the lowest. The return in the center of the list was taken as the median salary.

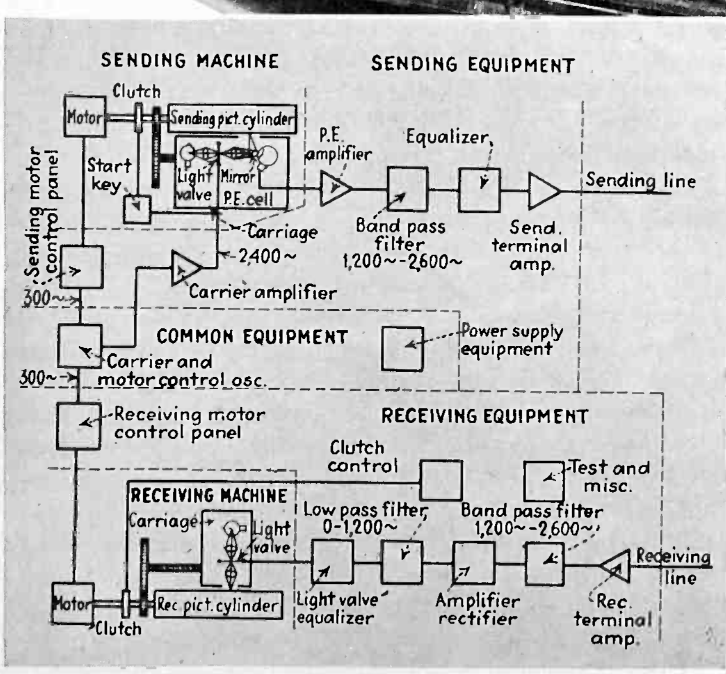
News photographs can now be exchanged between newspapers in 25 cities by means of the 10,000-mile Associated Press "Wire-photo" facimile system which went into service Jan. 1 (see front cover). Pictures 17 in. long and 11 in. wide (half a newspaper page) can be transmitted in 17 minutes. Scanning is at the rate of 100 lines per inch, and the carrier frequency is 2,400 cycles per second

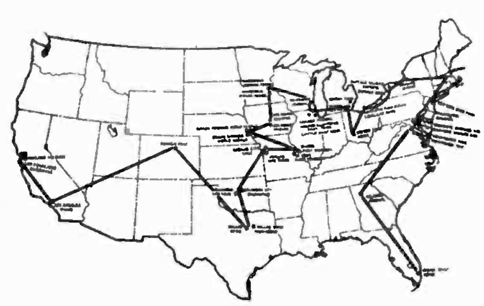


Associated Press opens WIRE-PHOTO SYSTEM



At the left is shown the sending machine. A light-beam one one-hundredth of an inch across, is chopped by a light-valve of the sound-picture type, 2,400 times per second, before striking the picture and being reflected back onto the photo-cell. Normal maximum line power is one milliwatt. Synchronization of all motors is accomplished by local tuning forks, giving regulation within one part in 300,000





The leased-wire circuit which links together 25 cities and 38 co-operating newspapers. Complete equipment was manufactured by the Western Electric Company

GERMAN GOVERNMENT

Hitler and Goebbels aim to have Fatherland lead world in new television development

INFORMATION coming from Germany and England indicates that a "television race" is on in those countries, to see which nation will be first to develop a practical system of television for wide national use. The Hitler administration has been pushing for an early introduction of television in the Fatherland, under the direction of Dr. Goebbels and the Propagandaministerium. Great radio and public address hook-ups are the fashion in Germany since *Der Fuehrer* took charge, and the added advantage of being able to "*see*, as well as hear," the national idol, has been shrewdly recognized, so that all pressure is now being put on television as a further aid to Nazi solidarity.

Meanwhile the English are determined that Germany shall not be first to introduce into Europe practical television for the masses. The British imagination has been touched by the recent British Empire broadcasts, linking together all the far-flung colonies. So the radio authorities have been told to get ready for visual tie-ups also, as soon as that becomes possible. The recent visit of the British Television Commission to the United States (see page 392, *Electronics* for December, 1934) was no mere junket or joy-ride, as some American skeptics supposed. Instead it was an earnest effort to learn about the best practice in the television laboratories of the world, in order to shape up a British television policy that will be second to none. The British Television Commission's report is to be issued shortly, and will undoubtedly lay down practical plans for the commercial development of television in England. Already, the British are having a bit of a boom in business, so that television may arrive contemporaneously with brighter days for John Bull.

Oblique type of cathode-ray tube used in the German Reichspost television receiver. This photograph was made at the Witzleben laboratory

But it is in Germany that the most effective aid from government has been received by television. The new Hitler administration has put itself squarely behind the development of television as an outstanding German achievement, and neither money nor effort are being spared to bring about this realization.

In the last six years millions of marks have been spent by the German government for television experiments in the official television laboratory of the Reichspost, Zentralamt (central office), Berlin—Tempelhof—well known in Europe under the abbreviation, "RPZ," as one of the finest research centers in the world. The chief engineer of this laboratory, Dr. F. Banneitz, is today one of the leading television experts of Europe.

In the year 1932 the German government erected what was then the greatest television transmitter in the world, and during 1933 a second ultra-short-wave transmitter was added, with an output of 16 kilowatts, used only for the radiation of synchronized sound accompaniment. The ultra-short-wave transmitter for the television picture works on a wavelength of 6.70 meters, while that for the sound channel works on 6.925 meters. The transmitters are on the air with a regular program 6 days in the week, from 9 a.m. to 11 p.m.

The transmitted picture has 180 lines, or 40,000 picture elements; 25 pictures are transmitted per second. According to the studies of E. W. Engstrom[1] such a picture is "minimum acceptable." In Germany another method of classification[2] has been found by which a picture of 180 lines is "84% recognizable."

Not only does the German government serve the German radio industry with an excellent daily television program, but Dr. Banneitz and his engineers have developed in the official television laboratory some very interesting devices, now used by the German radio industry for constructing television receivers to be sold at very reasonable prices. One of the RPZ television receivers was displayed at the recent Berlin Radio Show. This receiver uses a so-called "Braunsche Röhre" (cathode-ray tube) of the high vacuum type, with heater cathode, and a fluorescent screen measuring 15 by 18 centimeters (5.9 by 7 inches). The RPZ is likewise experimenting with chemicals to reproduce light-green, yellow and blue.

To secure dependable facts about the possibilities of relay transmission of television pictures the RPZ sent its television truck to a mountain in middle Germany in the early fall of 1934. This mountain (the famous Brocken) has a height of 3,700 feet, and is located by airline 125 miles from Berlin. Despite the fact that the Berlin transmitter is about 25 miles "behind the horizon," and about 3,000 feet below the horizon, fairly good reception of the Berlin television program could be received. (The antenna of the Berlin television transmitter is mounted on the old Berliner Funkturm—radio tower—453 feet above the ground.)

[1]E. W. Engstrom, Proc. Inst. Rad. Eng. vol. 21, December, 1933.
[2]R. Thun, Handbuch der Funktechnik, 1933, Stuttgart.

AIDS TELEVISION

Studies of transmitter practice, co-axial conductors, and home television sets promoted

The results of this experiment have been rather satisfactory, and the German government gave the Telefunken Company an order for a 5-kilowatt television transmitter to be delivered in 1935. This transmitter is to be provisional only. If the experiments with the relay transmission from Berlin prove satisfactory a larger television transmitter for relay transmission will be erected on top of the Brocken mountain.

The German short-wave station DJG last month announced the erection of three more television transmitters for Germany—in Munich, Frankfort am Main and Cologne. The announcement also stated that similar television stations soon would be erected in other principal cities.

Until the RPZ has more experience with relay transmission, the various German television transmitters are to radiate their own programs. The German Reichspost is conducting experiments in order to develop the possibilities of television transmission over conductors to connect the various television transmitters. Since 1932 a special high-frequency cable, having a length of 500 feet, has been used for connecting the television antenna upon the top of the old Berlin radio tower with the television transmitter set up in a building near the base of the tower. In the meantime considerable work has been done to construct a new type of cable for the transmission of a frequency band of 0-500,000 cycles, without distortion and without phase shift.

Use of co-axial conductors

Interesting cable types which fulfil the above specifications, one made by Siemens & Halske, and the other by the Telefunken Co., were exhibited at the Berlin Radio Show. The new cables have a damping per mile of 1.3-2.6 db. (measured at a frequency of 10^6 cycles). The Telefunken cable is of the so-called "Schalenkabel" (shell-cable) concentric type, and has a diameter of about 2 inches. To encourage the development of this new cable the German government gave an order for the manufacture of 10 miles of such co-axial conductor. This cable is to be used between the government laboratories in Tempelhof, a suburb of Berlin, and the television transmitter near the Berlin Funkhaus in Witzleben, also a suburb of Berlin. The airline distance between these two points is about 8 miles.

Another example of remarkable progress in German television technique is that of the new "outdoor-scenes" television truck, used by the Reichsrundfunkgesellschaft, also a government institution. This truck carries on its roof a standard motion-picture camera mounted on a cast-iron roof trunnion, allowing the camera to be moved in any desired direction. The hollow pillar of the camera support is used to convey the exposed film ribbon to the dark room of the truck interior.

By use of special apparatus and extremely fast working chemicals, the film can be developed in 20 seconds, though usually requiring about one minute. The still-wet film ribbon is then at once sent through a so-called "Abtastgerät," an apparatus with a scanning disk, with photo cell, "Gleichstromverstärker" (d.c. preamplifier), etc. The high-frequency impulses obtained are transmitted over the d.c. preamplifier, for a frequency range of 0-600,000 cycles, and then over a special high-frequency cable to the ultra-short-wave transmitter. The excellent results which this outdoor television truck produces were commented upon by observers during the recent Berlin Radio Show. On the opening day this truck was used to take the picture of Minister Dr. Goebbels during his opening speech. The television picture and his speech could be seen and heard 1¾ minutes after recording. Visitors to the show could also see their pictures displayed by the television receivers, which had been taken just 1¾ minutes previously by the television truck outside of the exhibition hall.

German television receivers

There are now five companies in Germany manufacturing television sets. The Telefunken company has two types of television receivers both using high-vacuum cathode ray tubes. The dimensions of the screens are 15x17 centimeters and 23x26 centimeters (5.9 by 6.7 and 9.0 by 10.2 inches). The Telefunken company is the only German company which has a screen material producing a black-white picture. However, the German observers state that the yellowish screen material also

[*Continued on page 30*]

One of the Loewe low-price television receivers which it is proposed to put on the German market to sell at a price below the equivalent of $300

Magnetic control of Thyratrons

By E. D. McARTHUR

Vacuum Tube Engineering Department
General Electric Company
Schenectady, New York

THE control of a gaseous discharge by electrostatic means has received a great amount of study[1] and made possible many new mechanical and electrical systems.[2] However, the possibility of magnetic control has been given relatively little attention[3] and, consequently, certain specific advantages of such control have not been recognized. The experimental work which is the basis for this paper was carried on to uncover the latent features of this method of controlling a gaseous discharge. In practice, the word control, when applied to a gas content tube, has come to mean the ability to specify the conditions which will prevent or insure current flow through the tube.

The principal requirement for breakdown in any given tube is a sufficiently high rate of positive ion generation. The rate of ion generation must exceed a definite minimum value determined by the applied potentials and dimensions of the electrodes.[4] In practice the ion generation rate and, therefore, the starting characteristic is fixed by the number of electrons which can leave the cathode and participate in cumulative ionization. Therefore, any method which controls the number of participating electrons will control the anode voltage at which the arc discharge will start. In the Thyratron, the pre-arc electron current is controlled mainly by the potential of the grid.

The work of J. S. Townsend,[5] I. Langmuir,[6] J. J. Thomson[7] and others has shown that, in a gas, electrons moving under the influence of mutually perpendicular electric and magnetic fields do not follow the direction of the electric field. The average direction of motion is inclined away from the direction of the electric field by an angle θ which may be calculated from the following relation:

$$\tan \theta = \frac{H\lambda}{u} e/m$$

where e/m is the ratio of charge to mass for an electron
H " " magnetic flux density
u " " velocity of the electrons $= 0.595 \times 10^8 \sqrt{V}$ cms/sec. volts
λ " " mean free path of electrons in the gas.

This relation shows that for a constant gas pressure the flux density required to produce a given angular deflection is directly proportional to the velocity.

MAGNETIC control of mercury vapor tubes has several advantages over the more conventional grid-control, among which are freedom from interaction between control circuit and load and the use of moving metallic bars as the control agent. New applications of these tubes to industry are thus made possible.

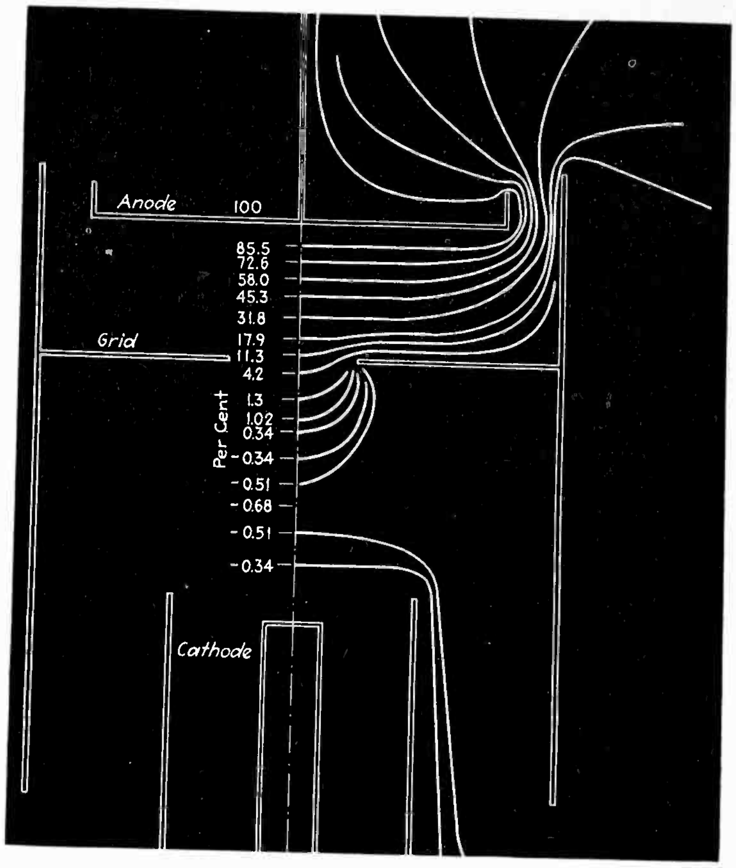


Fig. 1—Low potential values near the cathode permit easy magnetic control, as shown by this plot of the potential distribution in the FG-57 type of Thyratron

An experimental study of the potential distribution in various thyratron tubes shows that the volume bounded by the grid and cathode is a very low potential region. Figure 1 is a plot of this voltage distribution in the FG-57 type of tube for an electrode voltage combination corresponding to a point of breakdown. Electrons leave the cathode and increase in velocity as they approach the opening in the grid baffle. Most electrons do not have the velocity required for ionization until they reach the region of increasingly greater electric field near this opening.

If a transverse magnetic field be applied to this whole low velocity region, some of the electrons will be deflected from their usual paths and kept out of the strong field around the grid opening. These electrons will be collected by the grid or returned to the cathode, depending on the grid potential. In any case, the number of electrons available to cause ionization is reduced

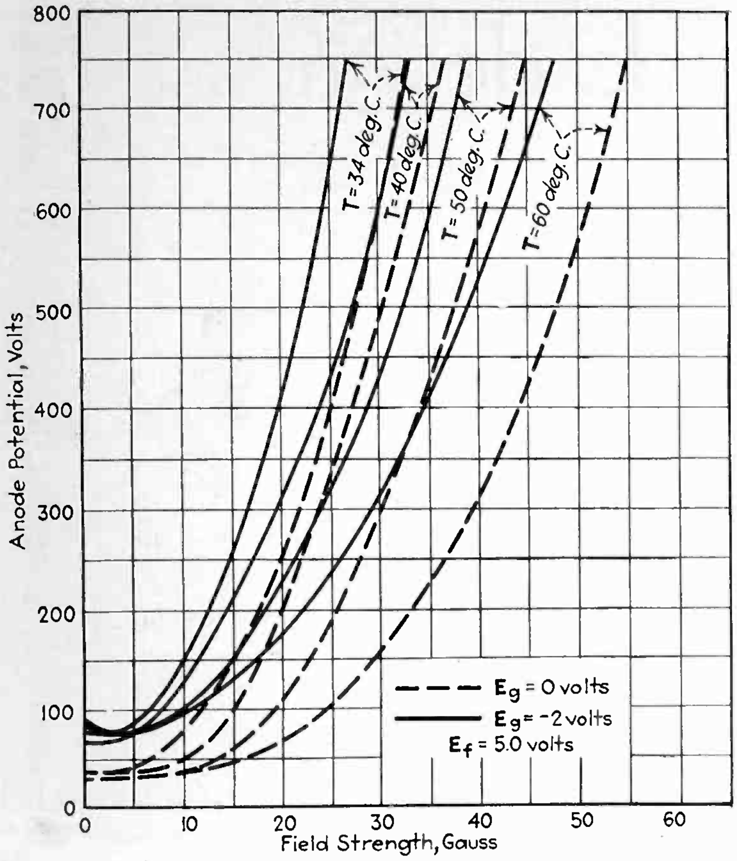


Fig. 2—Chart showing the break-down anode potential for different values of magnetic field, in the type FG-57

and breakdown will not occur until the electric field in the grid-cathode space is increased by raising the anode potential. Figure 1 shows that the electric field in a large part of the grid-cathode space is very low. Consequently, the electron paths can be bent through large angles with a weak magnetic field.

Experiments with two-electrode tubes have shown that a transverse magnetic field will deflect the electrons emerging from the cathode away from a direct line to the anode but ordinarily will not prevent breakdown. The reason for this is that the insulating tube walls build up a large negative charge which reflects the incident electrons. The electrons move along the wall until they reach the region of strong field near the anode and cause an arc discharge to start.

These considerations suggest the design principles for a magnetically controlled tube. In general these requirements are:

1. A large volume for a deflecting chamber.
2. Sufficient shielding so that the electric field in the chamber is low.
3. Conducting walls for the chamber.
4. A chamber at least partially bounded by the cathode structure.

Many standard controlled rectifier tubes meet these requirements and so should be susceptible to magnetic control. Figure 2 shows the magnetic control characteristics of the FG-57 tube. These characteristics can be predicted approximately from an equation of the form:

$$H = \frac{AP^{1/4}V^{1/2}}{1 + BE_g};\quad V > 150$$

where H = flux density in gauss
P = gas pressure in microns
V = breakdown anode voltage
E_g = grid voltage
A and B are constants determined by tube dimensions.

In the case of the FG-57 characteristics shown here these constants are $A = 0.88$ and $B = 0.076$. These static characteristics can be used to draw dynamic characteristics similar to Figure 3. The diagram shows the instantaneous plate voltage for one-half cycle and the flux density (φ_c) at which breakdown will occur. Since the direction of flux through the tube is immaterial, the curve of φ_c becomes a closed loop representing flux in either direction. Any value of flux outside this loop will prevent conduction. φ_i represents the flux supplied from a simple field winding operated from a.c. Current conduction begins at point *A*, the intersection of the applied and critical flux curves. The average value of current flow may be controlled by the use of the circuit arrangement shown in Figure 4. The field core is supplied with an a-c winding and two d-c windings wound in opposition. The flux through the tube consists of an a-c component of fixed amplitude varying about an axis determined by the value of the polarizing flux. The conduction point *A* may be shifted to any point on the characteristic by changing the value of the polarizing flux. Figure 5 shows the relation between average tube current and polarizing flux for a typical set-up. Similar control can be obtained by the use of a single a-c winding supplied from a phase shifting network or a selsyn motor.

Another type of tube—the FG-119—also fulfills the requirements for magnetic control. This tube is intended for use as a full wave rectifier and consists of a central cathode in the axis of two semi-cylindrical anodes. This tube can be used with an axial solenoid supplied with excitation from a regulating circuit or phase-shifting device. Since the tube and field are symmetrical, the single field coil serves to control both halves of the tube and results in a combination well adapted for use as a full wave controlled rectifier. On test the power output of such a rectifier was varied smoothly from

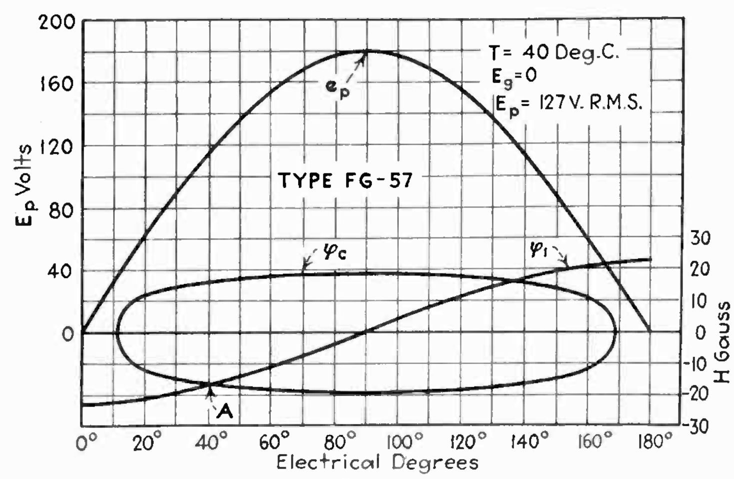


Fig. 3—Dynamic control characteristics, showing flux values (inside ellipse) at which conduction can occur

zero to 2.0 kw. using 90 volt-amperes excitation in the field. By power-factor correction the field excitation could have been reduced to about 10 watts.

Control may be effected not only by changing the magnitude or phase of the exciting current but also by varying the reluctance of the flux path. The use of an iron-cored field circuit containing an air gap for the tube, and an auxiliary air gap, provides a simple means of using the motion or position of an object to control the current flow through the tube without the need of intermediary equipment for changing the motion

[*Please turn to page 26*]

Advancements in ac-dc design

By PAUL WARE

RECENTLY the writer was given the following problem by Emerson Radio & Phonograph Corporation: Given outside dimensions for chassis, speaker and tubes of 9.0 by 4.0 by 6.5 inches, devise a universal (ac-dc) superheterodyne broadcast receiver conforming to the following:

1. A sensitivity approximating 200 microvolts absolute,
2. Selectivity consistent with layman-operated direct-drive tuning by means of seven-eighths inch diameter knob,
3. An output power of one watt delivered to a dynamic speaker mounted on chassis,
4. Incorporating an automatic signal overload limiting device,
5. Means provided for minimizing telegraphic signal interference in the region of the intermediate frequency,
6. No adjustable regeneration to be used,
7. Standard parts and tubes to be employed so far as possible,
8. Design must be economical for large production, that is, the subassemblies and the final assembly and testing procedure must be such as to permit of optimum minutes per operation for each class of work to be employed.

Obviously, there was not room for more than four standard tubes, and those selected were 1-6A7, 1-6F7, 1-43 and 1-25Z5. The intermediate frequency was made 456 kc. It was found necessary to mechanically con-

▲

THE PROBLEM—

TO design a receiver with given electrical characteristics and into a given set of physical dimensions.

THE SOLUTION—

IS given by Mr. Ware who shows how the modern small set is constantly improved in spite of its small size.

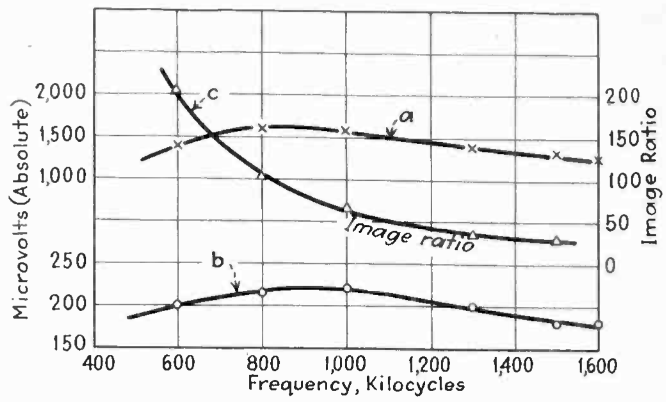


Fig. 1—Gain and image-ratio characteristics

strict the overall fore and aft dimensions of the five-inch dynamic speaker selected to be able to place a tube behind it. Doing this did not seem to adversely affect the speaker performance.

Triode as I-F amplifier

The pentode section of the 6F7 was employed as second detector, because it was found that the triode section was incapable of delivering sufficient voltage to fully utilize the 43 output tube. This was because of the limitation to about 100 volts in the plate supply. Thus it became desirable to use the triode section as an intermediate frequency amplifier if it could be arranged to function usefully. As far as gain was concerned, except for the special 6F7 connections, the circuit was of the usual arrangement. With the 6F7 triode section intermediate frequency stage out of the circuit it was found necessary to raise the antenna input to 1500 micro-

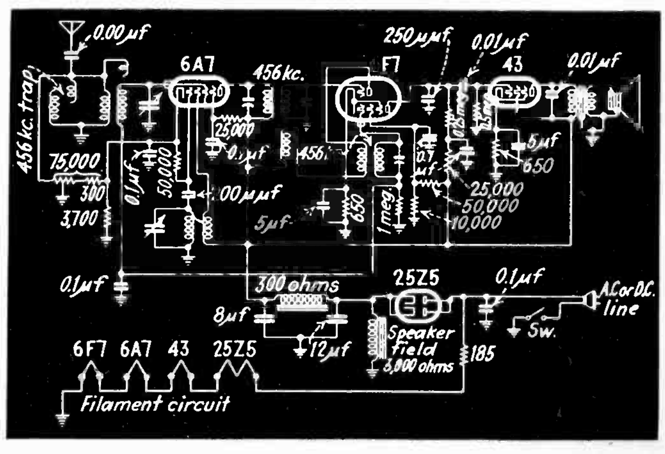


Fig. 2—Circuit of the 9 x 4 x 6.5 inch superheterodyne

volts to obtain standard output of 50 milliwatts. See Curve 1(a). This meant that the triode section alone must be designed to yield a voltage boost of seven and one-half to enable the overall finished set requirement of 200 microvolts to be met. As the selectivity [see Curve 4(a)] was considered sufficient without the triode stage, it was decided to design the triode stage to give the desired voltage gain but to add very little to the selectivity.

This amount of triode amplification was obtained by to the 6A7 input, as shown in the schematic diagram of Fig. 2.

Elimination of ship-to-shore interference

The schematic diagram also shows the method employed to reduce telegraphic interference originating on frequencies in the vicinity of 456 kc. A high impedance trap was connected across the high impedance antenna primary coil, and consisted of two small concentrically wound coils not connected together. The capacity between the coils and the coils themselves formed the resonant trap circuit. This unit is small and economical, and very effective. With the receiving set tuned to 600 kc., the 456 kc. attenuation ratio with and without the trap connected was approximately 30 to 1. As this is the equivalent of almost 30 db. down it will be seen that telegraphic interference breaking through the pre-selector is virtually eliminated.

The radio frequency tuning coil of the receiver was a simple solenoid, but its universal type antenna primary was wound with larger than the usual size of wire. This primary, tuned as usual just below the broadcast band in frequency, was found to have a good enough characteristic to enable reduction in the size of the usual added capacity to bolster signals at the higher frequency end of the band. This resulted in a reduction in the minimum capacity shunted around the antenna tuning coil and made possible a wider tuning range with given capacity range of variable condenser.

Combined antenna and 6A7 bias attenuation was the volume control circuit decided upon. Due to the high impedance of the antenna primary it was desirable to increase the volume control resistance above usual values employed in this type of circuit. It was found that a value of 75,000 ohms caused no noticeable loss when shunted around the antenna coil and this was the value used. Figure 2 shows the connection of a 3,700-ohm resistance to limit the 6A7 bias at volume control settings above this value measured from the 6A7 cathode. For smooth volume control action, the taper was made symmetrical and to have not over 1 per cent of its total resistance at 30 per cent useful rotation from each end, bunching therefore 98 per cent of the total, or 73,500 ohms within a rotation of 40 per cent in the center of rotation. This was found practicable.

Overall sensitivity and selectivity curves of the completed receiver are shown in Fig. 1(b) and Fig. 4 (b). Curves 4 (a) and 4 (b) were taken at 700 kc. for generator operating convenience. Selectivity taken at 1300 kc. was found to average 4.6 per cent wider in band width than at 700 kc. Figure 1(c) gives the signal to image ratio at various settings in the broadcast band. Figure 3 is a view of the completed chassis as it is now being made in continuous production.

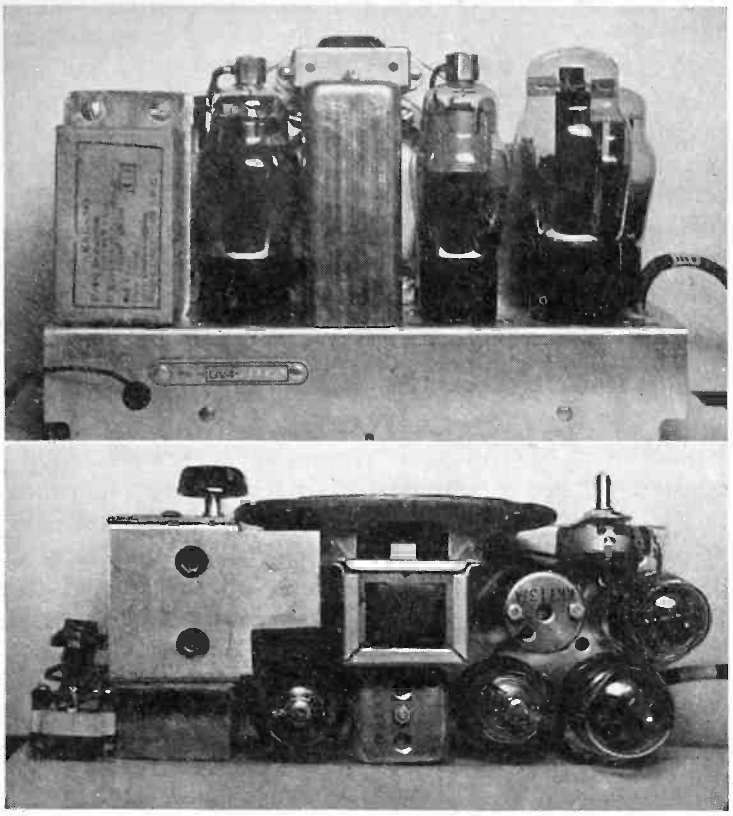


Fig. 3—Complete chassis of Emerson Model 19 as put into production

the use of a step-up, tuned secondary transformer utilizing an iron core. The diminutive transformer mounted inside an aluminum shield $2\frac{1}{2}$ inches high by $1\frac{1}{4}$ inches diameter, has, with its circuit, the characteristic shown in Fig. 4(c). This curve represents operating conditions, as it is the difference, between operation with and without the triode stage connected in the circuit, and consequently takes the benefit of any increase of regeneration caused by the increase in gain of the triode stage itself. It will be noted from this that the triode stage has added very little to the selectivity of the set, whereas the desired increase in gain was fully realized.

To prevent triode stage oscillation, a fixed reversed magnetic tickler coupled to the secondary tuned circuit of the first intermediate frequency transformer was inserted inside the shield of the first transformer. This transformer was of the newer pie-wound type with three coils each for the primary and secondary, which with the tickler made seven coils in all within the shield besides the two trimming condensers.

To restrain audio frequency overloading on strong signals any grid current drawn by the second detector was used to further bias down the 6A7 control grid. This was accomplished by the connection from the one megohm resistor in series with the 6F7 pentode section control grid being brought back

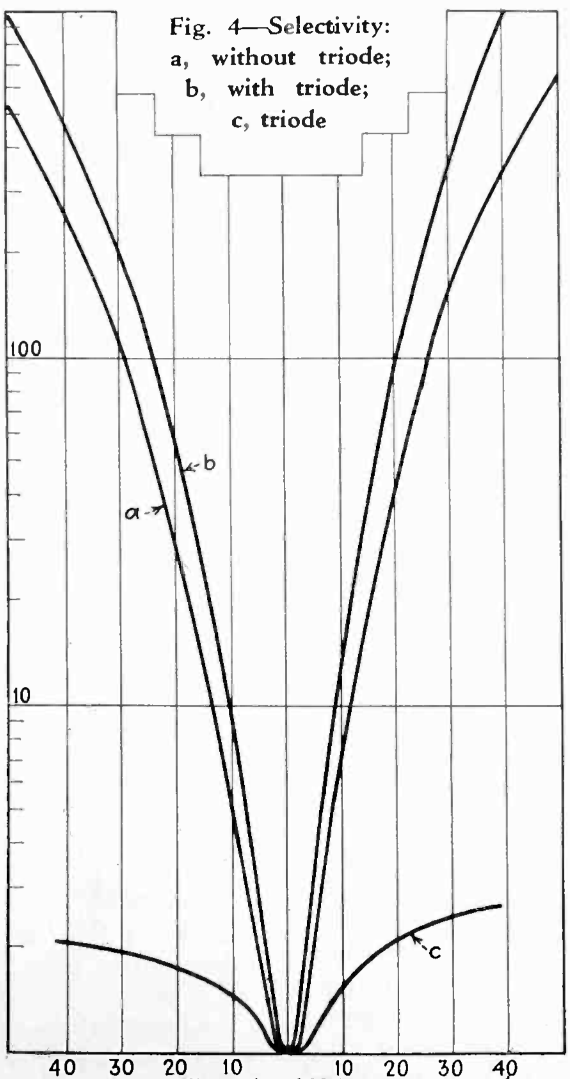
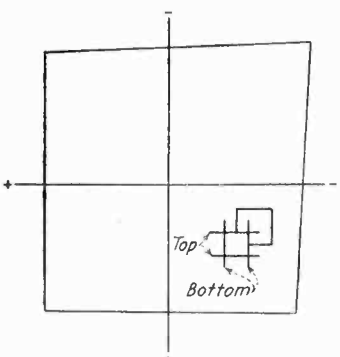


Fig. 4—Selectivity: a, without triode; b, with triode; c, triode

Elimination of distortion in cathode-ray tubes

By ALLEN B. DU MONT
*Allen B. Du Mont Laboratories
Montclair, New Jersey*

THE more exacting uses to which the cathode-ray tube is being applied have necessitated improvements in its structure to overcome some of the errors common to this type of tube. Formerly it has been the practice to calibrate the screen with suitable templates by the application of known voltages but this method requires time and is not always convenient. The tube to be described has a number of new features eliminating the more serious errors caused by non-uniform electrostatic beam deflection and at the same time maintaining constant internal resistance with varying deflection voltages.



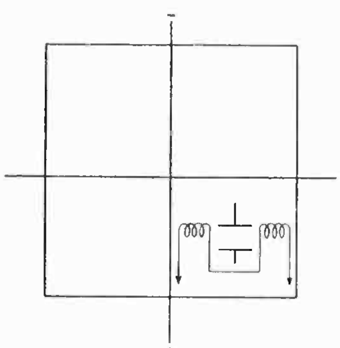


Fig. 1—(left) Distortion of pattern and position of plates causing it

Fig. 2—Pattern secured by using one set of plates and a deflection coil

The main causes of distortion in the pattern may be listed as follows:

1. Change in beam velocity caused by the deflection voltages.
2. Change in the internal resistance as the deflection voltages are varied.
3. Threshold effect in the case of gas focus tubes.
4. Varying length of path of the beam through the deflection plates.

Taking up the first case, we find that a considerable number of the cathode-ray tubes available have a direct connection inside the tube of one plate of each deflecting pair to the anode. Since, in normal tubes, the voltage required to give full scale deflection is from 5 to 15 per cent of the normal accelerating voltage, this electrode connection causes the effective accelerating voltage to fluctuate by ± 5 per cent to ± 15 per cent when full scale deflections are produced, the positive peaks applied to the isolated deflector plate being added to and the negative being subtracted from the effective accelerating voltage.

Figure 1 shows the pattern obtained with this arrangement and also the arrangement of the electrodes. On further analysis, if we take either set of deflection plates separately and apply an alternating voltage to them using coils for a sweep circuit, we obtain a pattern as shown in Fig. 2. Hence it will be seen that the distortion in each pair of plates by itself only causes a greater displacement of the spot from the zero axis when a negative voltage is applied than when a positive voltage is applied. However, as the two sets of deflection plates are placed at different distances from the anode and the electron beam first passes through one plate and then the other the second set of plates introduces a further

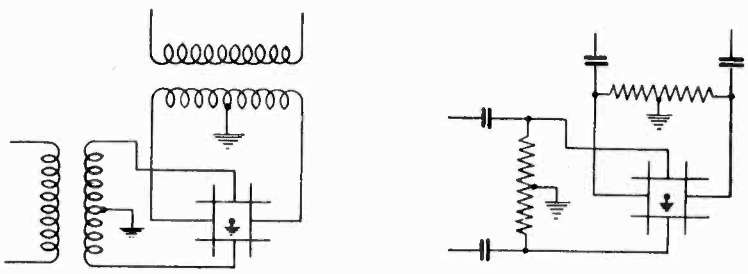


Fig. 3—Plate connections for correcting pattern distortion

error by affecting the velocity of the beam as deflected by the first set of plates.

To correct the distortion of the pattern caused by this effect separate leads from each deflection plate are brought outside the tube and connected in a symmetrical push-pull arrangement as shown in Fig. 3, in which both plates of a pair are connected to the anode through input circuits of equal impedance and oscillate in potential symmetrically about the earth potential of the anode.

The second and third causes of distortion can be eliminated by mounting the electrodes asymmetrically so that the normal position of the spot is at the edge of the screen at an angle 45 deg. from the normal axis. Suitable bias voltages are applied to the deflection plates so that the patterns appear as usual at the center of the screen. The characteristic curve of deflection-plate current versus deflection plate voltage is shown in Fig. 4. As the mount is so positioned that voltages to the left of the zero axis are only used for deflection it will be seen

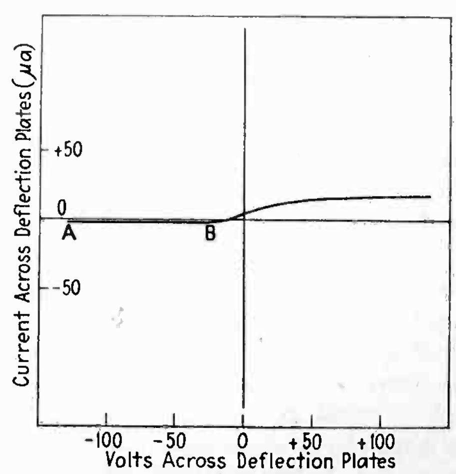


Fig. 4—Characteristic of deflection plate current

that the tube operates only on the portion of the curve between A and B and hence has a constant internal resistance as the deflection voltages are varied. Although this is not important in cases where the impedance of the circuit under test is low there are a number of cases where the tube is used with high impedance circuits where the change in internal resistance is objectionable.

The threshold effect is only encountered in gas focus tubes with deflection plates and does not occur in gas focus tubes with magnetic deflection or high vacuum tubes. Since the gas focus tube has a finer and brighter spot or trace, the elimination of the threshold effect (the main objection to the gas tube) is very important. The life of the gas focus tube is comparable to that of the high vacuum tube and can be used up to 10 megacycles successfully at which point the electron is deflected by a field which is no longer stationary at its peak value for the whole time taken by the electron to pass through the deflection system, and the resultant deflection is thus less than at lower frequencies. However, this same effect occurs in high vacuum tubes of conventional design but a special deflection system may be used which further extends their useful range.

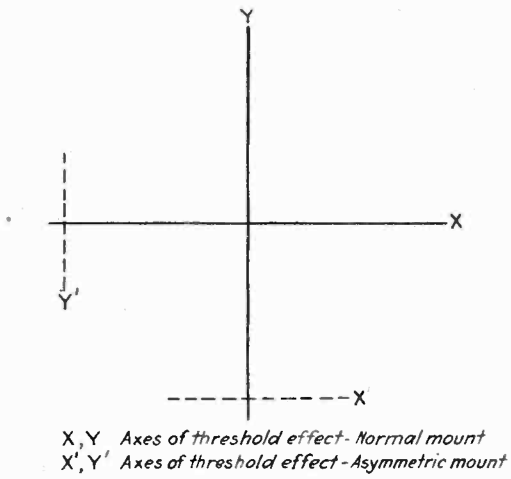


Fig. 5—Area of threshold effect in conventional and the newer tubes

In Fig. 5 is shown the area where the threshold effect occurs in a tube of conventional design and where it occurs in the special tube with asymmetrical mounting of the elements. It will be noticed that the useful area of the screen is maintained and a uniform pattern is obtained over its area. It might be well to mention that the cause of the threshold effect in gas focus tubes with deflection plates is caused by the collisional ionization produced by the beam in its passages through the space between the deflection plates leaving a space charge of positive ions with relatively low mobility. These ions effectively shield the beam from the influence of small negative potentials on one deflecting plate before linear response is established.

Distortion characterized by the varying length of the path of the beam through the deflection plates only occurs in the second set of deflection plates through which the beam passes since the deflection of the beam in the first set of plates is only at right angles to the plane of the plates. In the second set of plates, the beam may be deflected in any direction to the plane of the plates because of the combined effect of the first and second set of deflection plates. The error, however, is due to the motion of the beam parallel to the second set of plates caused by the deflection of the beam by the first set of plates. Figure 6 shows the variation of the length of the beam as it passes through the second set of deflection plates. Hence as the deflection is proportional to the length of path traveled through the deflection plates a minimum deflection is obtained when the beam

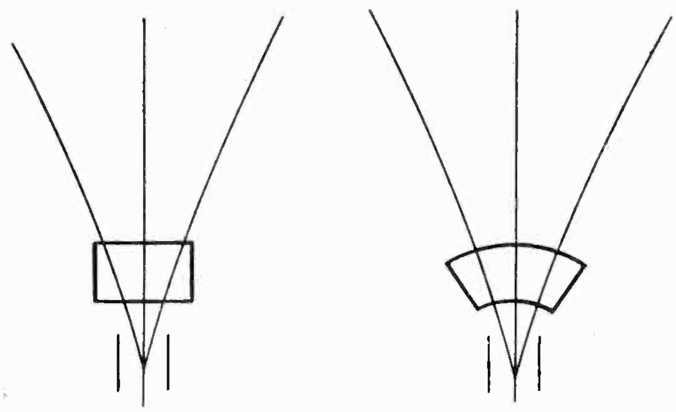


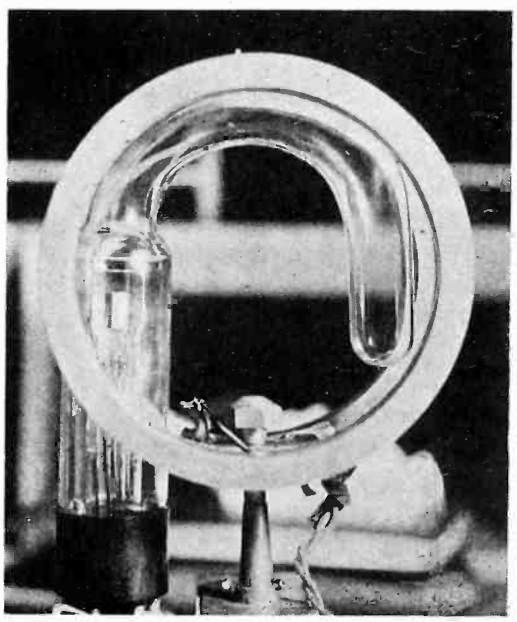
Fig. 6—Variation in beam length passing through tube and a means of avoiding such distortion

is at the center of the plates and a maximum when it is to the extreme right or left of the plate. By shaping the plates as shown at the right so that the length of the path is constant for any deflection uniform sensitivity is obtained.

A further advantage of this particular design is the fact that the spot or trace focuses uniformly over the entire screen. This has previously been a bothersome feature as the spot would focus well at the center of the screen but would be underfocused on one side and overfocused at the other side of the screen due to the fact that the bias voltage was constant but the effective accelerating voltage was changed by the deflecting potentials.

These improvements enable the cathode ray tube to be used for quantitative work without special calibrating screens and also permit more accurate wave analysis. When used for television reception a clearer picture is obtained.

ELECTRON YARDSTICK



Special cathode-ray tube made by Mr. Dumont by which e/m—ratio of the charge to the electron mass —may be measured

Signal-seeking circuits to aid correct tuning

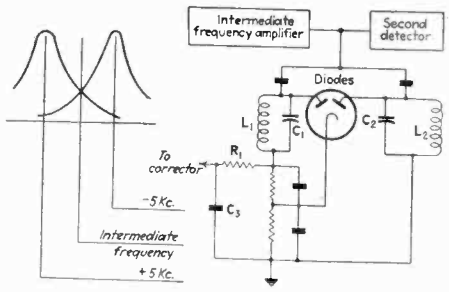


Fig. 1—Bridge for insuring correct tuning

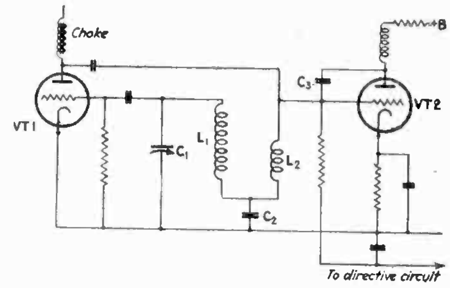


Fig. 2—Circuit for attaining the signal-seeking function

By S. Y. WHITE

As BROADCAST receivers approach the ideal selectivity curve the average user finds increased difficulty in tuning them. The better the set, the worse the quality of reception when inaccurately tuned. Even when the receiver is tuned to somewhere within the limits of the desired channel minor movements of the tuning indicator cause marked changes in tone, background noise and distortion. The provision of a tuning meter is an aid to ease of tuning, but not a final solution. The popularity of the small receivers is partly due to their relatively broad tuning, which gives sufficient selectivity for the reception of the local stations, and yet gives a minimum of off-resonance distortion.

To combine ease of tuning and selectivity requires a receiver which is incapable of adjustment substantially off resonance. It is not sufficient to design the receiver to be inoperative until the center of the resonance curve is aligned with a carrier, which then unblocks the receiver, as the locating of these isolated narrow peaks requires just the concentration and close manual adjustment we are endeavoring to avoid.

An obvious solution would be a detent to stop the receiver in the center of each channel. This would require too high an order of maintained receiver calibration, as well as producing a disagreeable drag in tuning from one station to another.

A more practical attack on the problem involves signal-seeking circuits, which allow the tuning indicator to be set anywhere in the desired station channel, and the circuit then "feels around" and adjusts the receiver to be in substantial resonance with the transmitter frequency. It is noted that exact resonance is hardly necessary, as ± 500 cycles is close enough tuning in most cases.

Design of signal-seeking circuits falls naturally into two parts. First is the means for determining whether the receiver be tuned above or below the transmitted frequency, which we may designate the "Directive Sense" circuit, and the other is the means used to effect the desired change in tuning, or the "Tuning Corrector" portion of the circuit.

In superheterodynes the logical place to attach the "Directive Sense" circuit is at the output of the i-f amplifier. We may set up a reactive bridge for frequency or phase with associated diodes so that we obtain no d-c voltage out if there is no signal, or if there is a signal that is accurately tuned; in the case of a signal tuned too high, a positive voltage will appear, and if the signal is tuned too low, a negative voltage.

The simplest means of accomplishing this is in Fig. 1. One tuned circuit is tuned a little higher and the other a little lower than the intermediate frequency, and their outputs balanced. This output is then filtered by R_1C_3, and either goes direct or through an amplifying tube to the "Corrector."

There are many ways to translate this "Directive" voltage into effects on tuned circuits we desire to shift. It is hardly practical to consider moving the main tuning control, as a motor or ratchets would be required. Some mechanical means might be considered to change a capacity in shunt to the tuned circuit, such as using a Rochelle salts crystal as the movable plate of a small condenser, or even using a section of electrostatic loudspeaker, which changes capacity slightly with applied d-c voltage. Two "electronic" methods are available—to change the inductance by saturating a magnetic core of part or all of the tuning inductance, or change the shunt capacity. Figure 2 shows the latter method.

It is well known that a triode with a capacitatively reactant plate circuit will degenerate through its grid-plate capacity, and reflect a poor power factor condenser into its input circuit. The amplitude of this effect can be controlled by control of the grid bias.

VT_1 is the normal oscillator of the superheterodyne which might be the inner elements of a 2A7. A padding condenser C_2 is also used as a coupling condenser to cooperate with L_2 to provide uniform strength of oscillation through the band desired by constant coupling the plate to the grid.

If VT_2 were across L_1 and the constants so chosen as to control ± 5 kc. at the lowest frequency desired, it would have a too pronounced control and damping effect on the higher frequencies, where the value of the tuning condenser is small. However, by using the same constant coupling elements we use for the tickler of VT_1 to produce uniform oscillation strength, we provide a constant ± 5 kc. control throughout the band. Since VT_2 is loosely coupled to the tuned circuit it must reflect larger values of capacity than are normally obtainable. The degenerative effect is therefore enhanced by having a small choke in the plate lead to provide maximum capacity reactance, and assisting the normal inter-electrodal capacity by C_3. This reflected capacity is controlled by the grid potential, as determined by a fixed bias and plus or minus the "Directive" voltage.

The advantage to the unskilled user is not alone in the elimination of the tuning meter, but in the fact that if a station is received at all it is received with the best quality the set is capable of giving.

Electronic Topics Feature AIEE Convention

January 22-24 meetings include 25 papers on tube applications

A STRIKING feature of the winter convention of the American Institute of Electrical Engineers, to be held in the Engineering Societies Building, 29 West 39th Street, New York City, January 22, 23 and 24, will be the large number of technical papers of interest to *Electronics* readers. Twenty-five different papers, presented under the auspices of the communications, welding, power, illumination, and noise-measurement groups, all relate in some way to the application or use of vacuum tubes and other electronic devices. Many of the papers have been published in recent issues of the A.I.E.E. journal, and will be presented only in abstract, leaving time for discussion. The subjects cover a wide range of topics, both in radio and communication, and also in non-communication and power applications of tubes and associated apparatus.

Special interest of electrical engineers is directed at the meeting of Wednesday morning when a system of direct-current, high-tension power transmission will be described, which results in greatly increasing the carrying capacity of existing lines and cables through the aid of rectifying tubes. The experiments to be discussed, involving transmissions up to 3,000 kw. of power, have grown out of the work of Professor Willis of Princeton University, conducted at Schenectady. The "electronic commutator" developed by Dr. Alexanderson for motors as large as 4,000 hp., will be described at the Thursday afternoon electronics symposium.

On Wednesday evening, the Institute's Edison Medal will be presented to Dr. Willis R. Whitney, vice-president in charge of research for the General Electric Company, "for his contributions to electrical science, his pioneer inventions, and his inspiring leadership in research."

A. L. Powell will speak on "New Illuminants."

TUESDAY, JANUARY 22

10:30 a.m.—Electrical Machinery

OUTPUT WAVE SHAPE OF CONTROLLED RECTIFIERS—F. O. Stebbins and C. W. Frick, General Electric Company.

10:30 a.m.—Communication

WIDE BAND TRANSMISSION OVER COAXIAL LINES—Lloyd Espenschied and M. E. Strieby, Bell Telephone Laboratories, Inc.

COAXIAL COMMUNICATION TRANSMISSION LINES—S. A. Schelkunoff, Bell Telephone Laboratories, Inc.

BROAD BAND TRANSMISSION OVER BALANCED LINES—A. B. Clark, American Telephone & Telegraph Company.

ULTRA SHORT-WAVE PROPAGATION IN URBAN TERRITORIES—C. R. Burrows, L. E. Hunt and A. Decino, Bell Telephone Laboratories, Inc.

Dr. Whitney, Edison Medallist

WEDNESDAY, JANUARY 23

10:00 a.m.—General Overhead Line Problems

CARRIER CURRENT RELAYS—O. A. Browne, Turners Falls Power & Electric Company, and W. L. Vest, Jr., Western Massachusetts Companies.

CONSTANT CURRENT D-C POWER TRANSMISSION—B. D. Bedford and F. R. Elder, General Electric Company, and C. H. Willis, Princeton University.

10:00 a.m.—Noise Symposium

MEASUREMENT OF NOISE FROM POWER TRANSFORMERS—A. P. Fugill, The Detroit Edison Company.

MEASUREMENT OF NOISE FROM SMALL MOTORS—C. G. Veinott, Westinghouse Electric & Manufacturing Company.

STANDARDIZATION OF NOISE METERS—R. G. McCurdy, American Telephone & Telegraph Company.

THE MEASUREMENT OF NOISE FOR ENGINEERING PURPOSES—B. A. G. Churcher, Metropolitan-Vickers Electrical Company, Ltd.

2:00 p.m.—Illumination

LOW PRESSURE GASEOUS DISCHARGE LAMPS—Saul Dushman, General Electric Company.

2:00 p.m.—Electric Welding

A NEW TIMER FOR RESISTANCE WELDING—R. N. Stoddard, Westinghouse Electric & Manufacturing Company.

A HIGH POWER WELDING RECTIFIER—Daniel Silverman, Arma Engineering Company, and J. H. Cox, Westinghouse Electric & Manufacturing Company.

HIGH VELOCITY STREAMS IN THE VACUUM ARC—E. C. Easton, Harvard University; F. B. Lucas, formerly Lehigh University, and F. Creedy, University of British Columbia.

THURSDAY, JANUARY 24

10:00 a.m.—Electronics Symposium—I

THEORY OF MULTIELECTRODE TUBES—H. A. Pidgeon, Bell Telephone Laboratories, Inc.

CATHODE RAY TUBES AND THEIR APPLICATION—J. M. Stinchfield, R.C.A. Radiotron Company, Inc.

LIMITS TO AMPLICATION—J. B. Johnson and F. B. Llewellyn, Bell Telephone Laboratories, Inc.

ELECTRONIC DEVICES IN THE FIELD OF MEASUREMENTS—J. W. Horton, Massachusetts Institute of Technology.

VACUUM TUBES AS HIGH FREQUENCY OSCILLATORS—M. J. Kelly and A. L. Samuel, Bell Telephone Laboratories, Inc.

2:00 p.m.—Electronics Symposium—II

RATINGS OF INDUSTRIAL ELECTRONIC TUBES—O. W. Pike, General Electric Company, and Dayton Ulrey, Westinghouse Electric & Manufacturing Company.

INDUSTRIAL ELECTRONIC CONTROL APPLICATIONS—F. H. Gulliksen and R. N. Stoddard, Westinghouse Electric & Manufacturing Company.

INDUSTRIAL APPLICATIONS OF ELECTRON TUBES—D. E. Chambers, General Electric Company.

THE "THYRATRON" MOTOR—E. F. W. Alexanderson and A. H. Mittag, General Electric Company.

THE "IGNITRON" TYPE OF INVERTER—C. F. Wagner and L. R. Ludwig, Westinghouse Electric & Manufacturing Company.

HIGH LIGHTS ON ELECTRONIC

A questionnaire for proposed photo-electric installation

MANUFACTURERS who are called upon to supply relay apparatus for photocell installations, often have much difficulty in getting by mail a full understanding of the conditions and requirements under which the photo-electric apparatus is to be used, and usually a long and tedious correspondence ensues before the full facts are obtained.

To prevent such delay, R. C. Hitchcock of the Westinghouse organization at Newark, N. J., has drawn up a series of questions, the answers to which are designed to supply full specifications. Here is the questionnaire:

A. LIGHT BEAM
- A-1. Will ordinary visible (incandescent white) light be used? (or) Must the light be practically invisible (infra red)?
- A-2. Is the light beam to be horizontal? (or) What angle is it from the horizontal?
- A-3. Will the beam be sent directly from source to phototube? (or) How many mirrors are to be used?
- A-4. What is the total length of the light beam?
- A-5. How large is the object (length, width, and height) which intercepts the beam? (or) What is the aperture size, through which the beam must pass?
- A-6. How far from the light source is the intercepting object?

B. PHOTOTUBE
- B-1. Is phototube to be inside relay housing? (or) If separately mounted, how far is it from relay?
- B-2. In the proposed installation, can sunlight, reflected sunlight, or strong artificial light enter the phototube housing?

C. AIR
- C-1. What is the room temperature range (Fahrenheit)?
- C-2. Will the relay be installed where excessive dampness exists?
- C-3. Will the housings be exposed to direct heat from the sun, etc.?
- C-4. Is equipment to be used outdoors? (If so) In what direction (approx.) will the beam be sent from source to phototube? (i.e., from south-west to north-east)

D. CONTACTOR
- D-1 How many complete operations are desired per minute?
- D-2. Give the characteristics of the circuit to be opened. (Volts—Amperes—Frequency.)
- D-3. Is the load highly inductive? (Describe the load.)
- D-4. Is contactor to be closed with light on phototube?
- D-5. Is contactor to be open with light on phototube?
- D-6. What is the minimum duration of complete light change for which relay operation is desired?

E. MOUNTING
- E-1. Is there a limit on the size of the housing?
- E-2. Will the phototube and light source housings (and mirrors, if any) be readily accessible for cleaning optical surfaces?
- E-3. Will mounting be from wall? Floor? Ceiling?

F. POWER
- F-1. Line voltage (actual max. and min., if possible).
- F-2. Frequency (if alternating current) cycles per second.
- F-3. Is the line solidly grounded?
- F-4. If relay is to be used 24 hours a day, what is the night voltage range?

G. SERVICE
- G-1. Approximately how many hours a day is relay to be used?
- G-2. How many days a week?
- G-3. What is the general nature of the proposed application?
  - a. Protection
  - b. Safety
  - c. Supervision
  - d. Control
  - e. Counting
  - f. Door operating

✦

U. S. Coast Guard's emergency truck

A RADIO STATION on wheels, officially known as an "Emergency Communication Truck," has been perfected for use by the U.S. Coast Guard in its Southern Area. It is the only one yet in use in the Coast Guard's farflung patrol system.

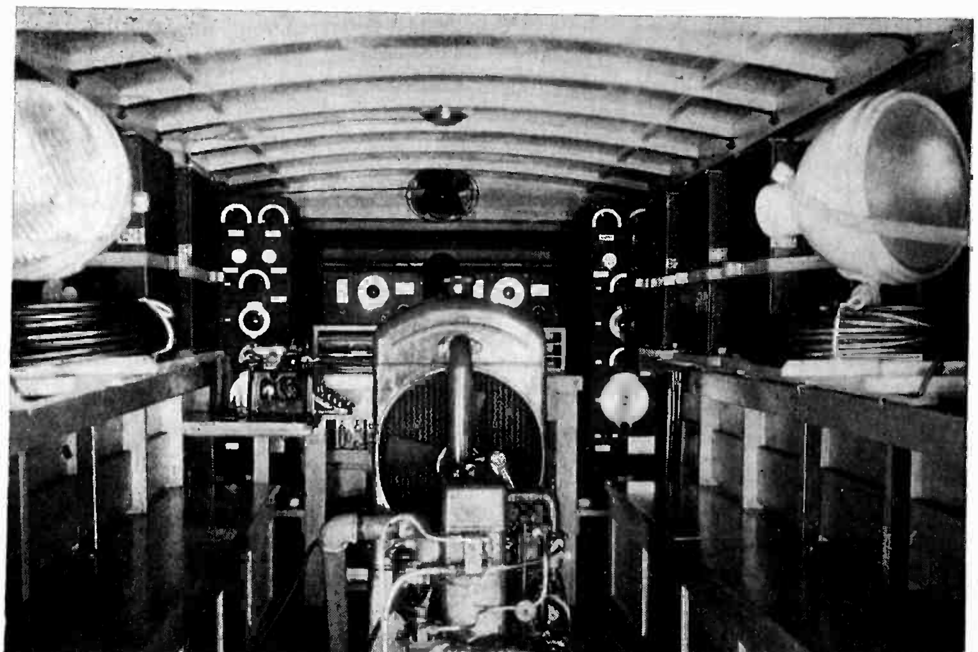
Equipment includes two 150-watt R.C.A. transmitters and two Westinghouse receivers. This enables the truck to go to the scene of a flood, storm or other disaster and make a quick report to headquarters in Mobile, out of which it operates, or direct to Washington.

In addition the truck is equipped with six portable transmitters and receivers designed especially by the General Electric Company. With these sets several persons can reconnoiter and make a report in either voice or code back to the truck station. The portables are of five watts rating.

The two large stationary transmitters on the truck cover practically the entire band of short waves, one operating between 2,000 and 4,200 kilocycles and the other between 8,100 and 17,050 kilocycles.

The truck is equipped with two 500 watt floodlights which can be mounted on the side as an aid in rescue work at the scene of a disaster.

A Kohler unit which starts automatically on a battery and operates by gasoline provides power for the radio and light equipment.



Interior of emergency communication truck used by the U. S. Coast Guard. The power unit, which starts on batteries, is located in the foreground (rear of truck). On shelves, back of the floodlights, are the portable transmitters and receivers, three to each side

DEVICES IN INDUSTRY + +

Coastwise vessels can now telephone to exchanges on land

A NEW TYPE of radio telephone equipment which enables captains of fishing vessels, harbor craft and yachts to have telephone service at sea, comparable with that on land was shown for the first time at the recent Marine Exhibit, 80 Broad Street, New York.

When within range of a coastal harbor radio-telephone station providing this service, captains are able by means of this equipment to talk to their offices, their homes, and in fact to almost any destination, all as easily as if they were on land. The captain merely picks up a telephone, located for example in the pilot house, presses a button on the instrument and says "Marine Operator." Promptly a voice replies with the familiar "Number Please" and the call goes through as do millions of land calls daily. When the ship itself is called, a selective device rings its bell but not that of any other ship.

The equipment designed by Bell Telephone Laboratories for the Western Electric Company consists of a telephone and a control unit, a cabinet about the size of a trunk which contains a 50-watt transmitter, and a superheterodyne receiver, and lastly a power unit. Crystal control keeps both transmitter and receiver on frequency at all times, eliminating tuning. One antenna serves for both sending and receiving.

A radio direction finder newly developed for use with this equipment gives bearings to within one percent accuracy, even at distances of several hundred miles. The direction of the incoming beam is registered directly on a scale in the pilot house.

✦

Watermarks centered by photo-cell

IN FINE PRINTING and engraving work, it is desirable to have the watermark in the paper fall in the center of each sheet of paper used. Formerly this has been difficult and almost impossible without careful inspection of each individual cutting operation.

The John F. Sarle Company, 50 Hudson street, New York City, announces that watermark localizing is now reduced to a science, by its new photo electric device. Banks, insurance companies, houses of issue for bonds, stocks, policies, etc., now have greater protection against forging, when watermark locationing is practiced. On special runs of private watermarks the same accounting can be made of every sheet and every scrap of waste, as though the run were of Government currency paper.

✦

Timing watches with jeweler's stroboscope

A NUMBER of jewellers are now making use of amplifiers and stroboscopic neon lamps to diagnose watch troubles and to adjust timekeepers rapidly, without waiting to determine the accumulated errors of several days.

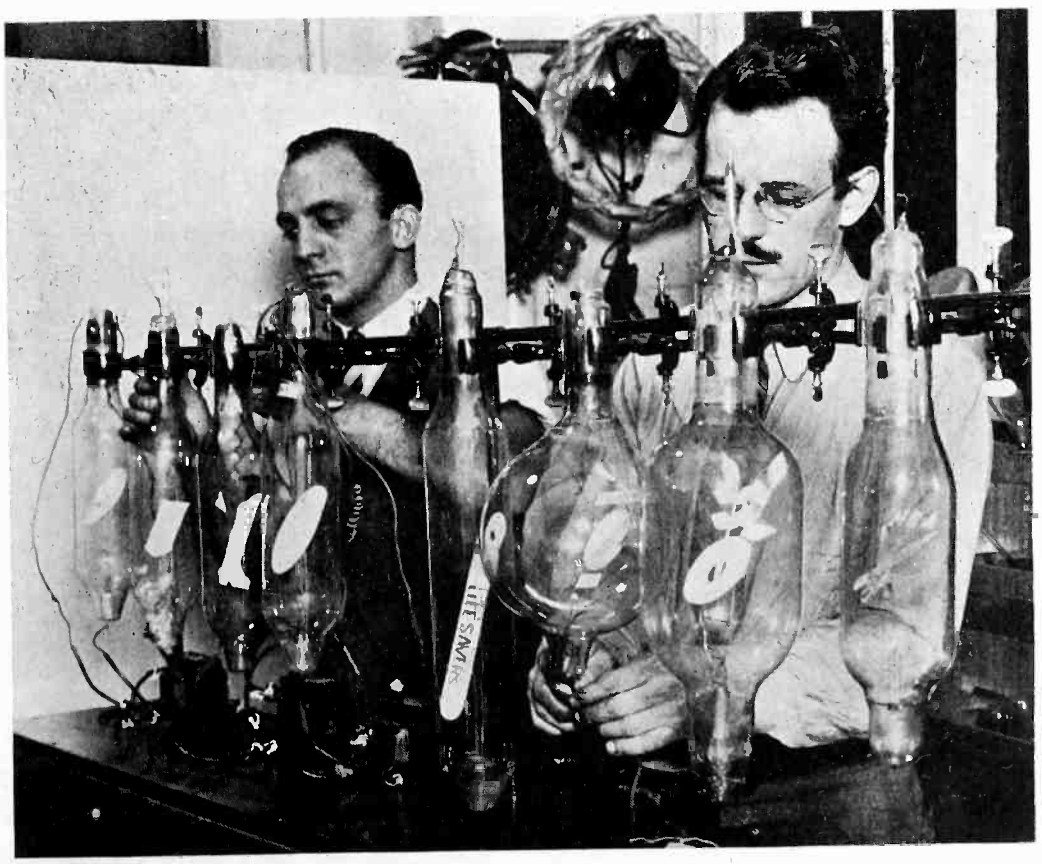
The first step is to lay the watch on a crystal microphone, enclosing the apparatus to shut out room noises. Volume is then turned up to bring out all the sounds of the watch. Many troubles developing in watch mechanisms have characteristic sounds that are too weak to hear with the unaided ear. An amplifier brings these sounds up to a level where they may readily be detected and a more rapid diagnosis of the trouble may thus be made.

The neon-lamp chronoscope provides a visual means of comparing the watch under test to a tuning-fork frequency standard.

A stroboscope disc is driven by the amplified tuning-fork frequency, and rotates at one revolution per second. The amplified watch tick is switched to "Time" position and will then flash the neon lamps behind this stroboscope disc. These flashes will occur 4, 5, or 6 times per second, depending on the watch, but as the stroboscope disc has only one hole, only one flash per second will be seen.

The disc and lamp are first lined up so that a flash occurs each time the disc hole passes before the lamp and observations may then be taken at intervals to determine the "drift" of the watch as compared to the tuning-fork. This drift will be seen by the flash gradually shifting from the starting position and occurring earlier or later than the arrival of the disc hole into view.

CATHODE-RAY ADVERTISING TUBES



A novel advertising-display type of cathode-ray tube has been developed by Gilbert T. Schmidling of the Eastern Electronics Corporation, Sperry Building, Brooklyn, N. Y. Fluorescent anodes reproducing trademarks in various colors, are made to glow under the impact of the electron streams. Some 400 different tints are now available

+ + NOTES ON ELECTRON

Cold-cathode oscillator drives power tube in transmission test

THE COLD-CATHODE tube developed by Philo T. Farnsworth and first described in the August, 1934, issue of *Electronics* (pages 242 and 243) was recently put to a conclusive test in San Francisco when it was used to drive a pair of 150 watt tubes in a short wave transmitter which maintained contact with Honolulu on 35 meters. The cold cathode tube was supplied with an anode voltage of 1,100 volts, and drew a current of 30 milliamperes. In previous tests it was found that an undistorted output of 25 watts could be obtained from an input of 35 watts, an efficiency of 71 per cent.

✦

Neon tube condenser tester

BY GLENN H. BROWNING

THAT ELECTRON devices are taking the place of many conventional pieces of apparatus is illustrated in a new device for testing condensers. This apparatus which determines the electrical condition of the condenser by measuring the leakage up to several hundred megohms employs a neon tube instead of a meter.

In fact this tube has many advantages other than cost. Consider the circuit shown in Fig. 1a where R is the leakage resistance of the condenser C. Let E be the voltage and M a meter for the measurement of the leakage R. In order to measure R, the sensitive meter M must be shorted while the condenser receives its initial charge Q. The meter circuit is then opened and the leakage current read. The leakage resistance R may be calculated by the voltage divided by the current.

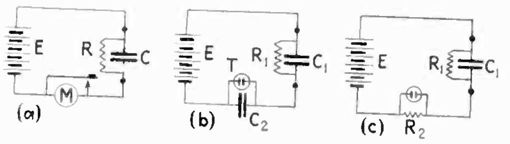


Fig. 1—Condenser leakage test

Now replace the meter by a neon tube with a condenser across it as shown in b. As is well known a neon tube has the property of "tripping off" when a certain critical voltage is applied, and the gases in the tube give rise to visible light. At potentials less than this critical voltage, the neon tube acts electrically as a small capacitance, thus when the voltage E is applied to the circuit both the test condenser C_1 and the condenser across the neon tube C_2 receive the same initial charge Q. Due to this charge Q, the voltage across C_1 or E_1 is Q/C_1 and the voltage across the neon tube E_2 is Q/C_2. If E_2 is greater than the critical voltage, the neon tube lights up for an instant, partially discharging C_2. If the test condenser C_1 has a very high leakage resistance, it will take a considerable time (minutes sometimes) to again charge C_2 to a voltage high enough to light the neon tube. Consequently with a circuit of this type, where C_2 is correctly proportioned to the range of condenser it is desired to test, good condensers will give flashes of the neon tube of one a second or less, while condensers whose resistance is below a certain specified value will give several flashes in a second.

To test condensers with relatively low resistance, the neon tube is shunted by a suitable resistance instead of a condenser. Such a circuit is shown in

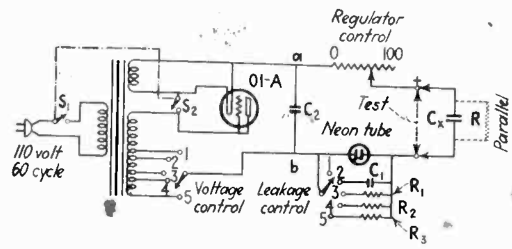


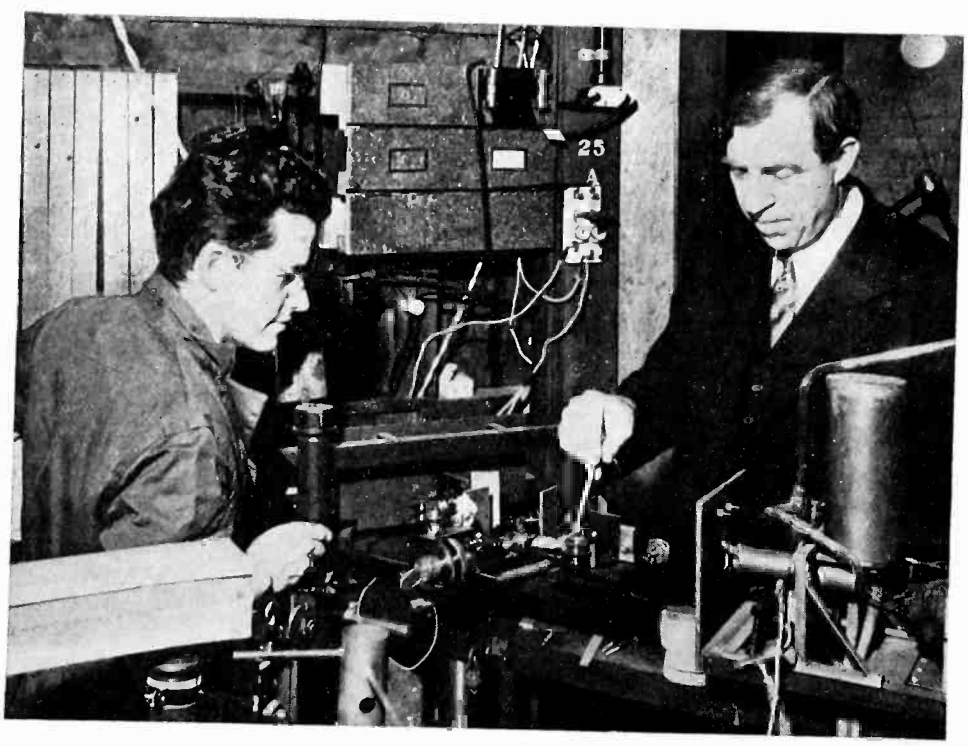
Fig. 2—Complete condenser tester

c. The resistance R_2 is set at a specified value for the condenser under test C_1. Voltage is applied. The initial charging current which flows into the condenser gives an IR^2 drop across the neon tube sufficient to light it. If the leakage resistance R_1 is high the initial flash is the only one. However if R_1 is low, the neon tube continues to be light. In the case of an electrolytic condenser, this leakage resistance rapidly increases if the condenser is good, and as a consequence the neon tube is extinguished after a few seconds. If an electrolytic condenser has had no voltage applied to it for some time, it is necessary to leave it on test for a few minutes before condemning it, for an appreciable time is taken to reform the film on the anode, which disintegrates somewhat when the condenser is idle.

The advantages of the neon tube in testing condensers are thus obvious, for it will indicate whether a condenser is open (no charging flash), shorted (continuous glow) or has a high or low resistance. Furthermore condensers may be tested at their approximate working voltage, a condition which is necessary if accurate information is to be gained concerning their condition.

Figure 2 shows a circuit diagram of a condenser analyzer which the writer helped design for the Tobe Deutschmann Corporation, incorporating the principles outlined above.

CORNELL'S NEW SPECTROMETER

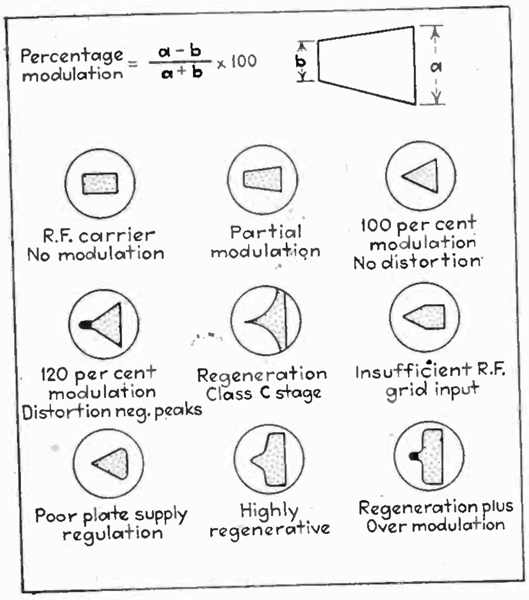


Prof. F. K. Richtmyer and R. E. Schrader (left) with the double-crystal x-ray spectrometer recently installed at Cornell University. A spectral analysis of gold has already been accomplished, using this instrument

TUBES AND CIRCUITS + +

Modulation measurement by cathode-ray tube

IF THE MODULATING voltage (a-f) is applied to the horizontal deflecting plates and the modulated voltage (r-f) to the other plates of a cathode-ray tube, the resulting figure will be a solid trapezium provided no phase shift occurs. If phase shift occurs the sloping lines become ellipses, the eccentricity of which depends upon the amount of the phase shift. By shunting



the a-f output by a variable condenser the trapesium may be restored.

Various patterns secured by the use of such a device in a broadcast station are shown in the figure contributed by Allen B. Dumont.

✦

Notes—

WANTED—a new antenna flat from 16 meters up through the broadcast band. A first detector that eliminates tweets on the second harmonic of the intermediate frequency. This can be accomplished by reducing the preliminary r-f gain; but this increases the noise-to-signal ratio.

WETLESS—in Australia they call "dry electrolytic condensers" the reversed English term "wetless."

6C6-77—The difference between these two tubes, according to Virgil Graham, is "an external shield and 3 cents."

7-METER THERMOCOUPLES—in a certain radio station where experiments are going on with a 7-meter transmitter, thermocouples have been found burned out, although there was no connection to their terminals. Is it possible that the natural period of these devices is in this region and that the circulating current in them is sufficient to burn them out?

Excuse it, please

IN THE CIRCUIT diagram on page 356 of the November issue of *Electronics*, showing the connections for the single-tube beat frequency oscillator, the 16 volt grid bias batteries shown in series with each grid lead should be omitted, and the ground should be connected to the movable arm on the bias resistor to provide the proper grid voltage.

In the article "High fidelity program circuits," page 342 in the November issue, the thirteenth line from the top of the left hand column should read "(above 0.006 watts)."

✦

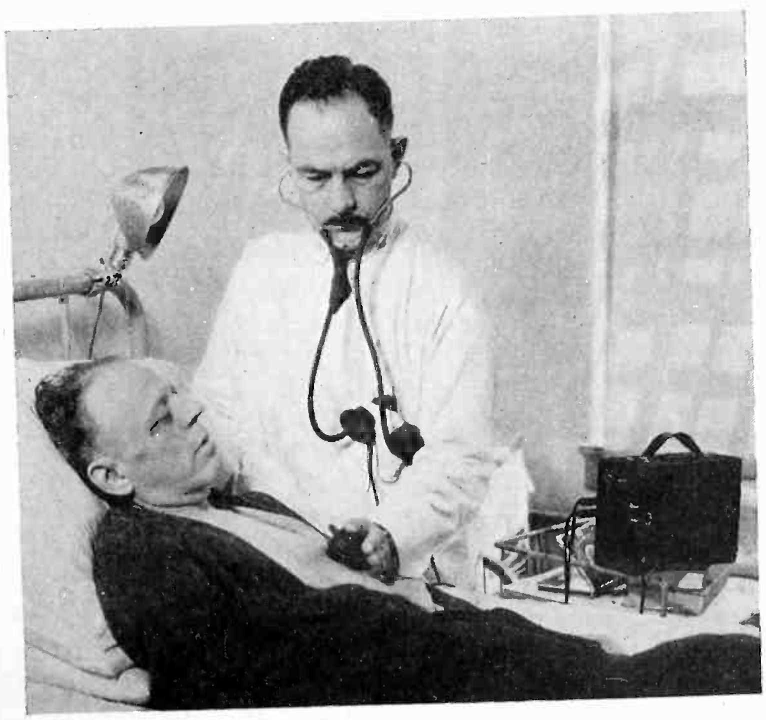
4-ounce amplifier for heartbeats

A PORTABLE electrical stethoscope containing a complete two-stage amplifier has recently been made available to the medical profession by the Western Electric Company. Originally developed for a medical student whose poor hearing prevented him from using the ordinary type of stethoscope the new type of instrument has found wide application not only with physicians having poor hearing but also those who must make examinations in noisy places. A special tuning filter is incorporated in the amplifier to emphasize certain faint heart sounds which may be especially important in the diagnosis.

The pick-up device which is held against the patient's heart is a magnetic microphone. Since most heart tones are low the pick-up is designed to transmit low tones efficiently. A two-stage amplifier operating with two "peanut" tubes and two miniature transformers with cores of permalloy amplify the original power by 100 times. Only four flashlight cells for the filaments and two small dry batteries for the plates are employed.

The use of the adjustable electrical filter for tuning in certain heart sounds makes it possible to separate the natural sounds from the unnatural ones. The thumping of the heart, its loudest sounds, produces frequencies lying mostly below 100 cycles. The blowing and whistling which accompany certain heart ailments are much fainter and also higher in pitch, going as high as 1200 cycles. By throwing a switch the physician can listen to the low or high notes depending upon the necessity of the diagnosis. The large hospital type of electrical stethoscope has been in use for some time, but this device is not as widely applicable as the portable stethoscope, which can be carried by the physician conveniently wherever he goes.

PORTABLE HEARTBEAT AMPLIFIER



Dr. Hollingsworth of the Veterans Hospital, Hines, Ill., demonstrates the new Western Electric electronic stethoscope. The amplifier weighs 4 ounces

electronics

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O. H. CALDWELL, *Editor*

Vol. VIII —JANUARY, 1935— Number 1

Keep stepping on the gas

HENRY FORD'S advice to the automobile industry for 1935 has its application in many other fields as well.

"Don't depend upon 1934 momentum for your 1935 speed," counsels the sage of Dearborn, in effect. Put on additional pressure for 1935! The new year must develop its own sales impetus and pull ahead of 1934 under its own power.

Recovery started in the year just closed. Recovery should proceed much further during 1935, and carry the radio and electronics fields far ahead during the months to come.

AIEE---IRE---Radio Club

THE wealth of technical papers on radio and electronic subjects to be presented at the winter convention of the American Institute of Electrical Engineers at New York City, Jan. 22 to 24, calls attention to the fact that three associations of national standing now serve as outlets for papers on radio and related topics. The Institute of Radio Engineers naturally feels itself headquarters for technical information on radio, but in recent months its proceedings have fallen far behind in publishing papers presented by IRE authors. The Radio Club of America is a third organization whose meetings and papers have attracted many radio men because of their informality.

Sooner or later conflict is bound to come between the operations of these three outlets for radio technical developments. Friends of all three should take steps to co-ordinate their operations and fields. A similar confusion arose some years ago between the AIEE and its older but smaller prototype, the New York Electrical Society. Good judgment dictated a clear-cut definition of the fields of each, and so possibility of conflict and misunderstanding was eliminated. Similar definition is needed for the fields of the three association forums for radio.

Where the trouble lies

A STUDY of thousands of cases of radio interference which were traced to their respective causes by a large utility organization, revealed that nearly one half of the trouble was caused by appliances and circuits on the electricity-user's own premises. Motors, thermostats, loose lamps in sockets, faulty switch contacts, armored cable rubbing against pipes, etc.—these were some of the common causes of noise in the listeners' radio sets. The utility lines themselves proved to be responsible for about 14 per cent of the trouble. Another 17 per cent was classified as external, due to interference from trolley contacts, industrial plants, and other local causes.

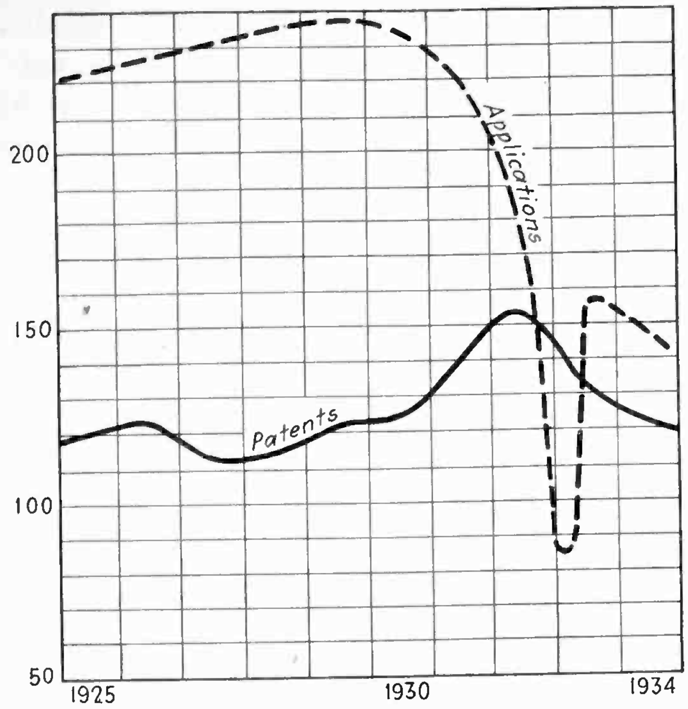
The lesson of this survey lies in the large proportion of sources of trouble found right on the listener's own premises. It points out the need for an educational campaign to the public so that listeners may learn how to clear their own troubles—which will be half the battle.

Recent trends in U. S. patents

THE effect of the recent financial stringency on applications for United States patents, if not on invention itself, is interestingly shown by the chart herewith, which reveals how the rate of 250 patent applications per day, from 1925 to 1930, dropped to a low of 86 per day between December, 1932, and March, 1933. Following the bank holiday, however, a flood of delayed applications poured in upon the examiners.

About 60 per cent of the patents applied for

PATENTS AND THE DEPRESSION



How number of applications received daily fell off. Lower curve, compiled by S. W. Balch, patent attorney, Montclair, N. J., shows number of patents issued per day.

are now being granted. To put through a patent at present takes on the average 34 months. One patent for a calculating machine recently issued, was filed in 1912, issuing after a delay of 22 years. The design patent for the Blue Eagle, however, was put through in five days.

Another index of interest in patents has been the attendance in the search room of the Patent Office at Washington. After having been crowded for many years, a recent visit there showed it to be almost deserted. Inventions in radio and electronics may be increasing in number, but the returns from the rural sections in the form of applications for patents on nut-locks, tobacco pipes, cow-tail holders, and the like, seem to have reached an all-time low!

The electronic telescope

IN these columns we have had the temerity to suggest that the great new 200-inch telescope now being erected in California, at a cost of many millions, might be outdated by some electronic-amplifier super-telescope, even before the huge new glass on Mt. Palomar can be completed. We have also proposed that with an infra-red television scanning element, the progress of solar eclipses might be watched despite clouds and unfavorable weather. We think that the future improved tools of the astronomer will come from the electronic field.

Dr. A. M. Skellett of the Bell Telephone Laboratories now proposes to apply these principles to observing the sun's corona, making the faint glow of the "prominences" fully visible despite the glare of the sun's direct rays. He says:

> "If the image of the sky around the sun's disk were scanned spirally out from the solar disk, the resultant photoelectric current would be made up of several parts. There would be a large direct current due to the masking glare, a smaller low-frequency component due to the variation of brightness of the glare as the scanning spot moves out from the sun, and a spectrum of high-frequency components of relatively low intensity, caused by the passage of the spot over the hoods, arches and streamers of the coronal image. By passing this composite current through appropriate filters, the high-frequency components due to the corona could be separated from the low frequency and direct current components due to the glare. The coronal components could then be amplified and reconverted into an optical image."

Already Dr. Skellett's method has been applied to a laboratory "corona" with encouraging results. The new science of "celestial electronics" comes closer.

▼ ▼ ▼

BRAILLE RADIO-DIAL FOR BLIND

In this new combination radio-phonograph "talking book" developed by the American Foundation for the Blind, Grand Central Palace, New York City, the dial markings are in raised Braille characters. Long-playing records of standard books and popular novels are now available in libraries for the blind

Magnetic control of Thyratrons

[*Continued from page 13*]

into an electrical impulse. This auxiliary air gap may be used in conjunction with such objects as moving bars carried by elevator cars, automatic scales, cutting machines, or machine-driven discs carrying magnetic inserts to give synchronous control of another process.

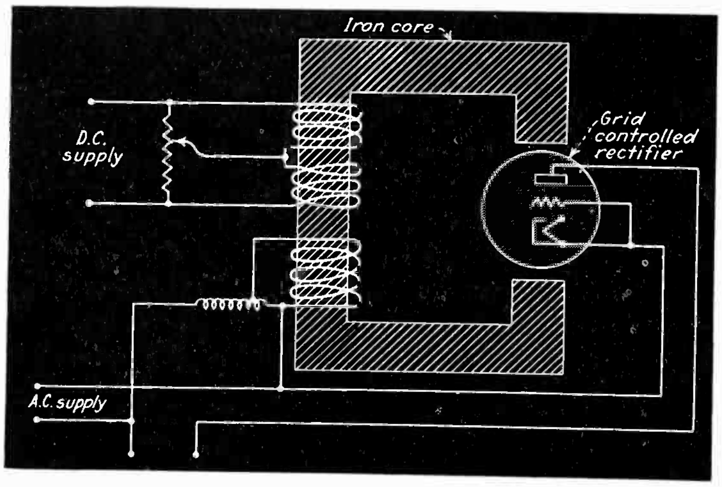


Fig. 4—Circuit arrangement for magnetic control of grid controlled rectifier

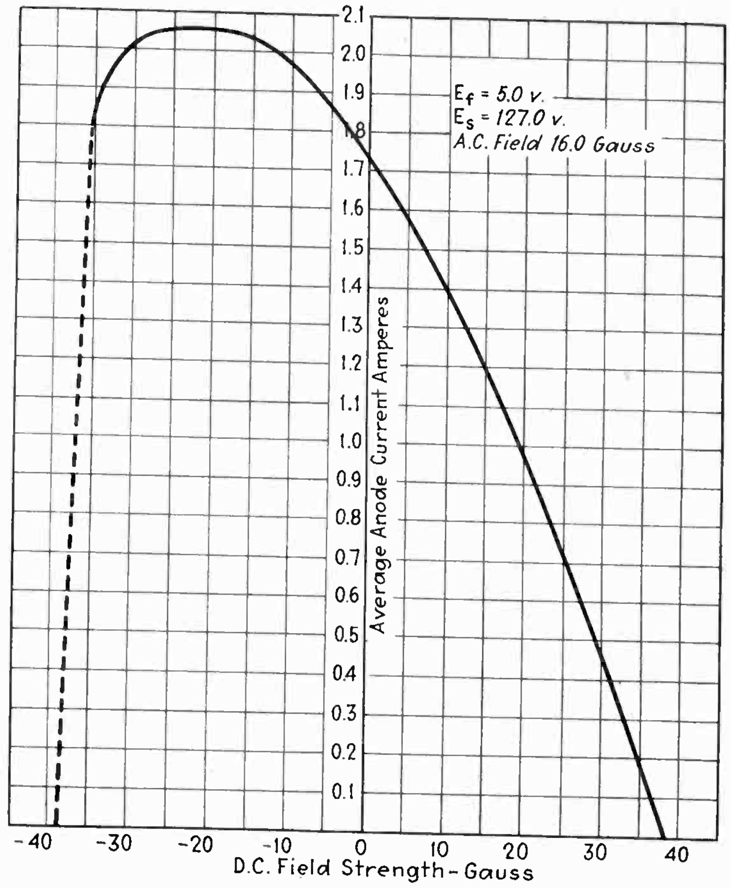


Fig. 5—Anode current v.s. d.c. magnetic field strength

Many other circuits are made possible by the simultaneous use of electrostatic and electromagnetic control. In this way, control may be obtained from two independent sources or from circuits where interaction is undesirable.

Magnetic methods of control have certain advantages which are valuable. There is no coupling between the load and control circuits and, consequently, no interaction. Furthermore, since there is no conducting path between the control field and the tube, the control circuit can always be operated at ground potential without regard to the anode or cathode potentials. The post-arc grid current in the electrostatically controlled tube has no parallel in magnetically controlled tubes. Consequently, the design of the magnetic circuit is always the same regardless of the tube current to be controlled. The only point to be considered is the change in vapor pressure with load. Magnetic control of thyratron tubes should be considered supplemental to grid control and the two methods should be given equal consideration in the solution of a problem. In this way, the designing engineer is given greater latitude in his choice of operable systems and can select the one best suited to a particular project.

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A NEW BOOK FOR USERS OF ELECTRON TUBES

Higher Mathematics for Engineers and Physicists

By I. S. and E. S. Sokolnikoff, Professor and Instructor in Mathematics, University of Wisconsin. McGraw-Hill Book Company, Inc. 1934. (480 pages. Price $5.00.)

NUMEROUS books have purported to be short cuts to the higher art of mathematics, royal roads by which the engineer may not only review his "math" but may add to his repertoire the various brands of higher mathematics. These books have usually been too simple, or too difficult. The present book errs, if at all, on the side of being difficult. As such it is intellectually stimulating.

It is no simple problem to cover all important phases of our complex mathematical learning in a single volume. It seems to fulfill well the aim of the authors to "bridge the gap which separates many engineers from mathematics" and to acquaint them with such matters as elliptic integrals, determinants, vector analysis, Fourier series, improper, multiple and line integrals, probability, differential equations—in short the higher mathematics which most engineers evade in college and which, later, they wish they knew more about.

This reviewer, having occasion to go into vector analysis, found a better explanation of curls, gradients, divergences in this book than that found in other bird's eye views of mathematics he has read.

A REVIEW OF THE ELECTRONIC ART HERE AND ABROAD

Recent electron-tube literature

THE FOLLOWING articles appearing in October and November, 1934, *Electrical Engineering* are of interest and importance to all designers and users of electron tubes.

On the general subjects relating to controlled rectifiers and their applications there are the following articles:

Thyratron Tubes in Relay Practice by Rolf Wideröe, October, p. 1347.

New Timer for Resistance Welding by R. N. Stoddard, October, p. 1366.

High Power Welding Rectifier by D. Silverman and J. H. Cox, October, p. 1380.

The Ignitron Type of Inverter by C. F. Wagner and L. R. Ludwig, October, p. 1384.

Thyratron Motor by E. F. W. Alexanderson and A. H. Mittag, November, p. 1517.

On high vacuum tubes and their uses there are the following articles:

Limits to Amplification by J. B. Johnson and F. B. Llewellyn, November, p. 1449. An excellent bibliography on the subject of amplifier noise appears in this article.

Theory of Multielectrode Tubes by H. A. Pidgeon, November, p. 1485.

Vacuum Tubes as High Frequency Oscillators by M. J. Kelly and A. L. Samuel, November, p. 1504.

The "Luxembourg effect"

IN RECENT MONTHS, a new kind of interference, not due to lack of linear response or selectivity has been observed, the so-called Luxembourg effect of which a special study has been made by the Philips Laboratories at Eindhoven (Holland), under the direction of B. van der Pol. In

Carriers giving Luxembourg effect at Eindhoven

these tests the Swiss sender Beromunster (100 kw.; 556 kc.) emitted its carrier wave at given intervals, while the sender Luxembourg (150 kw.; 230 kc.) was sending out a strongly modulated signal. If now Beromunster was tuned in at Eindhoven, the unmodulated signal was found to have picked up the Luxembourg music while traveling to Holland, so that Luxembourg could be received on 556 kc., the modulation amounting to 8 per cent at 100 cycles and 1 per cent at 800 cycles per sec. The effect is only observed at night, and when the ground wave of the wanted sender does not affect the receiver while the distance between the long wave sender and the receiver should not exceed 100 miles. In more recent tests Luxembourg has also been heard at Eindhoven on the carriers of Radio-Paris (182 kc.) Munich, Lyons, Strasbourg, and at London on Beromunster, Trieste, Breslan, etc. The effect is stronger the longer the wave-length of the unwanted station. This interaction of radio waves is attributed to a non-linear action in the ionosphere.

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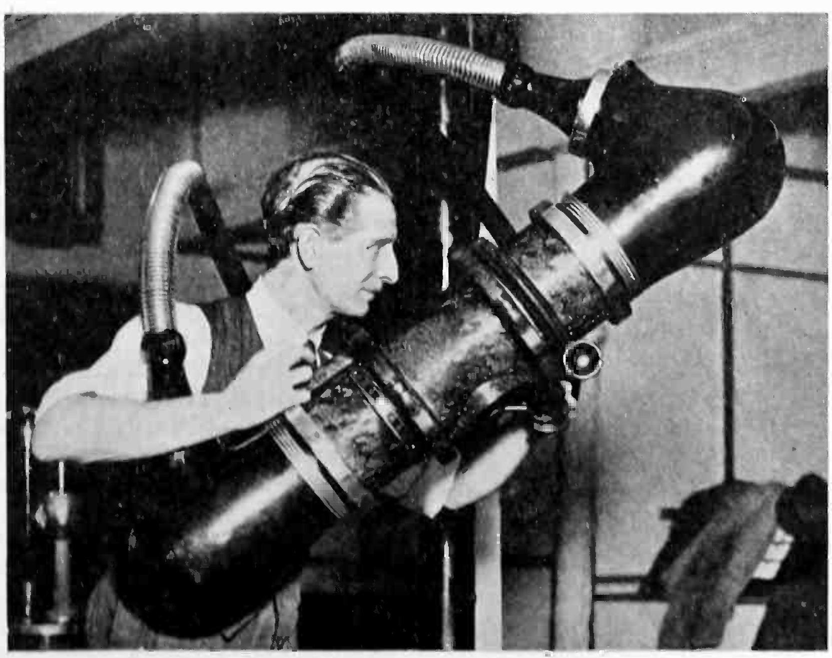
250,000 VOLT X-RAY TUBE



Deep therapy tube exhibited at the Radiological Exhibition in Westminster, London. This tube is so constructed that it is shock proof

Tube prices in Germany

THE FOLLOWING communication from Dr. W. F. Ewald, Berlin, comments on the article by Wilhelm Schrage in October *Electronics*, "German Radio Receivers." Doubtless Mr. Schrage used actual prices paid for tubes in this country (many of them can be bought widely for as low as 39 cents) and not list prices when comparing American and German tube prices.

"The author declares tube prices to be about 8 to 10 times higher in Germany than in U.S.A. and explains this by an alleged tube monopoly. He continues to attribute the popularity of reflex circuits to the high price of tubes. These statements can be easily disproved.

"Not only the prices of tubes but also those of sets and components are considerably higher in Europe than in U.S.A. The list price of a modern HF Pentode, such as the 57, is $1.10 or Marks 4.62 at gold parity. The German list price for the corresponding tube is Marks 13.50, or less than three times the American price. A modern frequency changer, like the 6 A 7, costs $1.30 in U.S.A. and Marks 18.00 in Germany, which is a little more than three times the American price. The ratio in other tubes is similar.

"Now the German tube prices are practically the same as those prevalent, for instance, in Great Britain, where there are numerous tube manufacturers and no question of anything like a monopoly. The reason for the higher European prices has nothing at all to do with the number of tube manufacturers but with general conditions of production, which prevail for all sorts of radio (and other) articles. Comparatively simple components, like variable condensers, cost about double the American price in Germany or Britain, in spite of the fact that they are manufactured in similar quantities. The slightly greater difference in tube prices is easily explained by the enormously greater American tube production (U.S.A. to Germany—about 7:1), which is chiefly due to the general organization of broadcasting. The American system of distributing transmitters has always necessitated highly selective receivers and consequently the employment of more tubes (average number of tubes per set about double the European figure). European set manufacturers have, until recently, found their chief market in sets with one or two tuned circuits and two or three tubes (plus rectifier). The tendency has therefore been to use few but highly efficient tubes, a trend which must of necessity lead to comparatively high tube prices. The main reason, however, for the difference in set and tube prices lies in the lower degree of mechanization in European industry, as expressed by employment figures, which differ at 2:1 per manufactured set. For evident reasons there is no inclination, at present, to save labor and increase unemployment in order to be able to cut prices.

"As to the assertion that reflex circuits owe their popularity to high tube prices, the latter have prevailed for very many years with slight changes while reflex circuits are a phenomenon limited to the current season. There is every reason to believe that next year will see no more of them. They owe their existence merely to the price policy of the Manufacturers Association which unintentionally favored this type of circuit. This situation which has been anything but satisfactory to the industry, will be remedied by next season."

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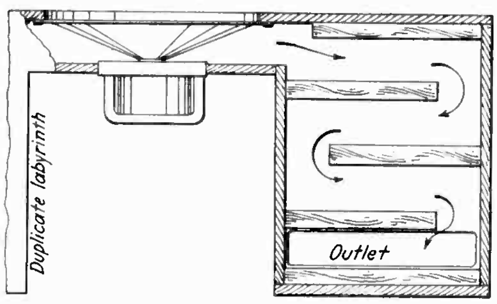
Acoustical labyrinths for high-fidelity reproduction

ACOUSTICAL engineers have long realized that the efficiency of radio-set loud speakers at the low frequency range can be improved by the use of an acoustical filter to load the speaker. Recently a set manufacturer (Stromberg Carlson) has installed in a cabinet an acoustical labyrinth which is designed to greatly improve the low frequency response. The set employs high and low frequency speakers, both of the dynamic cone type. The division of input power between the two speakers is performed in the output circuit of the amplifier by a simple network of condensers and an air-core coil. The high frequency



speaker is provided with a set of deflector vanes which improve the uniformity of sound distribution from the high frequency source. The range of this high frequency speaker extends from 2,500 to 10,000 cycles per second and extends the frequency characteristics of the low frequency speaker without changing the level of the sound.

The low frequency speaker (60-2500 cycles) has high efficiency secured by the use of a 40-watt field. This speaker is capable of using the full capacity of a 30-watt amplifier without perceptible overload. To improve the low-frequency efficiency the labyrinth mentioned above has been placed into the cabinet of the receiver which acts as a low frequency load. In the usual receiver the low frequencies discharge into the back of the cabinet. The cavity resonance which occurs from this cause produces a boomy effect which is far from realistic.

In this receiver, however, the back of the loud speaker discharges through an acoustical conduit which is built into the cabinet itself. This conduit is folded in the form of a labyrinth of many sections, as shown in the accompanying illustration. The end of the conduit opens to the bottom of the cabinet, which insures the same essential length of acoustical path regardless of the position of the set in the room. The acoustical passage is of such a length that the fundamental resonance occurs in the frequency range where the efficiency of the cabinet as a baffle begins to fall off. The conduit serves, therefore, to extend the low frequency range of the system beyond the limit made possible by the cabinet itself. Thus the response characteristic of the system over the entire frequency range is much better than that provided by the same speaker mounted in a flat baffle of equivalent size. Since no sound is allowed to radiate through the back of the receiver cabinet the position of the set from the nearest wall does not affect the tone qualities.

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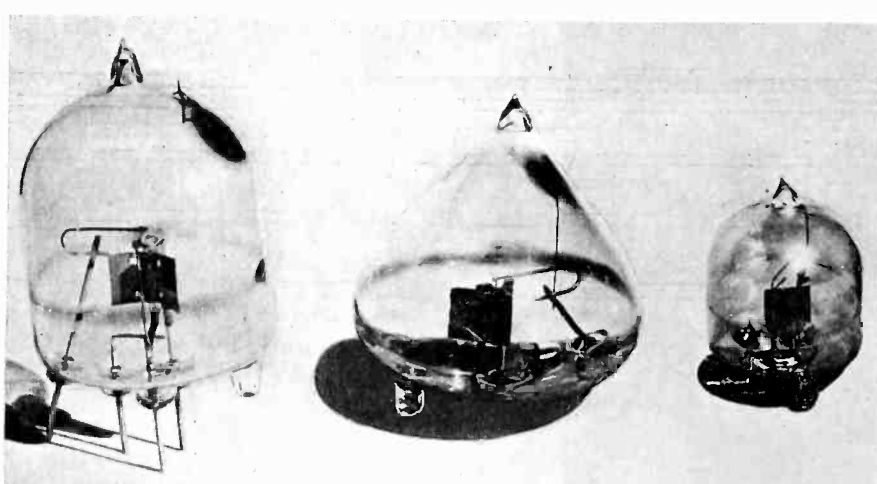
ULTRA-HIGH FREQUENCY TUBES



These experimental tubes (Bell Laboratories) are new research tools for the region below 10 meters. The tube at the left will generate 6 watts at 500 megacycles; the middle tube produces 10 watts at 670 Mc. at an efficiency of 20 per cent; the right hand tube delivers 1 watt at 1,200 Mc. at 10 per cent efficiency

Frequency-changer tubes

THE METHOD of producing the intermediate frequency with the aid of separate oscillator and detector tubes, preferably a screen grid tube, to the control grid of which the signal is applied together with the oscillator output, suffers from interaction between signal and oscillator frequency circuits, and radiation is likely to occur unless an r-f stage is provided between aerial and first detector. Single screen grid or pentode tubes used for producing local and beat frequency show this defect to an even greater extent. Heptodes (or pentagrid tubes), octodes and triode-hexodes) have been adopted as a remedy.

The main feature of all these tubes is that the plate current depends on the voltage of two separate grids one of which may influence the other, that is, a change e_1 on the first grid does not necessarily produce the same change in the plate current when the potential of the fourth grid varies at the same time or remains at its former value. It is only necessary that the slopes of the i_p–e_{g_1}

curves differ from one bias of the first grid to the other without the characteristic being curved for this reason. The increase in plate current due to the combined changes e_1 and e_2 may be written—

$$i = g_1 e_1 + g_4 e_4 + G_1 e_1 - g_1 e_1$$

or $$i = g_1 e_1 + g_4 e_4 + \frac{G_1 - g_1}{e_4} e_1 e_4$$

where $(G_1 - g_1)/e_4$ is now a separate variable going through a maximum for a definite e_4. The product of two frequencies, which is equal to their sum and their difference, appears in this way. The same result is obtained as if the i_p–e_g curve were to contain a quadratic term.

In the heptode (or pentagrid) the seven electrodes all lie in the same electron path, thus forming a true single tube and not merely an assembly of triode and tetrode in the same bulb. Grid 1, nearest the cathode is the oscillator grid, while grid 2, in the form of two wires parallel to the cathode acts as the oscillator anode.

The oscillator plate and grid are connected in a local oscillator circuit in the usual manner. The stream of electrons to the oscillator plate 2 varies in intensity in the rhythm of the local r-f wave; a portion of this current goes to electrode 2, while the remainder passes through the screening grid 3, which together with grid 5 is forming an electrostatic screen around the control grid 4. Grid 4 further controls the electron stream before it arrives at the cylindrical plate, which surrounds the entire discharge space. The output transformer is tuned to the intermediate frequency.

The electrodes are arranged so as to give variable-mu features when the control grid bias is varied.

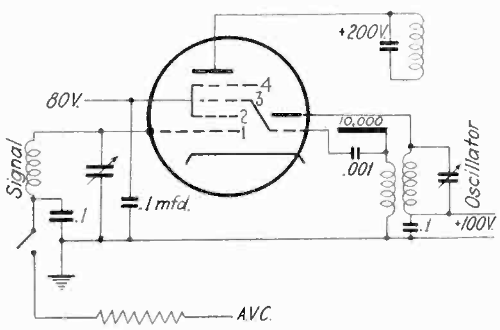
The main plate current and the oscillator grid voltage are connected by the relation. $i = e_4 g_{4,0} (a e_1 + b e_1^2)$, where $g_{4,0}$ is the slope of the i_p–e_g at zero oscillator voltage, e_4 the instantaneous e_g measured from the point about minus 10 volts, toward which the family of i_p–e_g curves with a given load converges for different oscillator grid voltages. When $e_1 = E_{01} + E_1 \cos p_1 t$, and $e_4 = E_{01} + E_4 \cos p_4 t$, the plate current will contain their product and therefore the frequencies $(p_1 + p_4)$ and $(p_1 - p_4)$ with the same strength, the maximum amplitude of either being equal to

$$E_b = g_{4,0} E_1 E_4 (a + 2b)/2$$

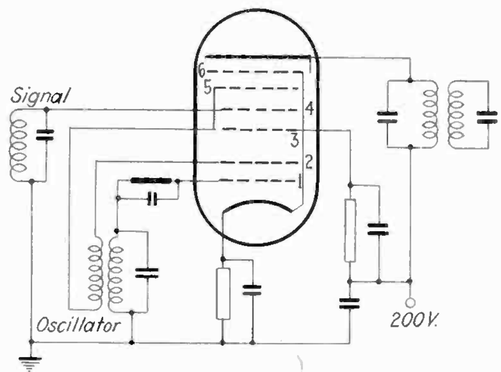
where a and b are the same empirical constants as before. The maximum value of the amplitude of the beat frequency current divided by the maximum amplitude of the local frequency voltage E_1 is therefore—

$$g_c = g_{4,0} E_1 (a + 2b E_{01})/2;$$

this ratio is called the *conversion conductance*. When using a grid lead and condenser to ensure stable oscillations, grid 1 is thereby maintained at a negative potential, approximately $-E_1$, with respect to the cathode. The value of the oscillator grid bias required for suppressing the plate current is very nearly



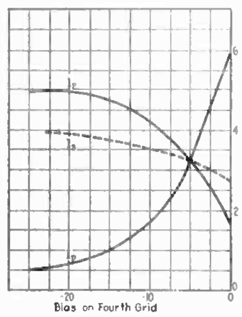
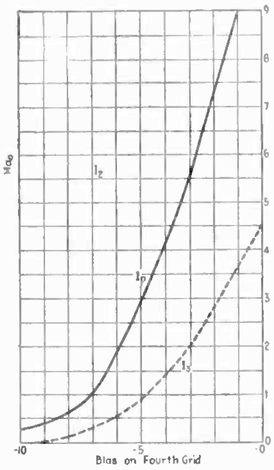
Triode-hexode connections



Octode connections

$C = E_{01} + E_1$, and the highest conversion conductance is obtained for $E_1 = C/2$. In a well-known tube this value is equal to 10, and with $a = 0.0011$, $2b = 0.0049$ the conversion conductance then becomes equal to about $g_{4,0}/8$ where $g_{4,0}$ is one to three ma. per volt.

Plate currents plotted against plate voltages, in the range between 150 and 250 volts, furnish a family of divergent straight lines issuing from a point x, about —850 volts, the steepest line being obtained for $e_4 = 0$ and e_1 slightly negative. At maximum beat current amplitude the amplification factor (ratio of plate voltage change to change on the fourth grid when both produce the same change in plate current) for a given load R is equal to $g_c/(1/R + I_p/E_p)$, where I_g is the mean plate current and E_p the plate voltage measured from X. The mean plate current may be found by integration over one cycle, or for values of E_0 between $C/2$ and C, over the positive half-cycle only. This conversion amplification, as it is

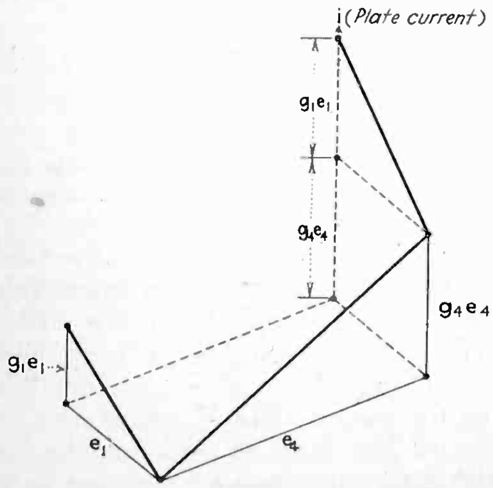



Typical heptode (left) and hexode characteristics. I_2 = oscillator plate current; Ip = main plate current.

usually called, remains below 100.

The pentagrid or heptode tube has not fulfilled all the hopes set upon it, at least not the type manufactured in Europe, one serious disadvantage being that when the voltage on the control grid becomes more negative, the output current falls, while the oscillator anode current tends to rise. This is equivalent to a negative mutual conductance between the control grid and the oscillating anode and a signal applied to the control grid may cause the oscillator plate voltage to vary. The result of this coupling is suppression of resonance (interlocking) in the oscillating circuit, the oscillator oscillating with the external rather than its own frequency when the difference between the two frequencies is not too great.

The solution which has found favor in France and Holland is the octode which merely adds a suppressor grid, but ensures higher amplification, an amplification which remains constant down to a wave-length of about 7 m. and varies little when the beat amplitude varies from one to two. Apart from this it functions much like the heptode. The formula for the conversion amplification is the same. German set-builders give the preference to the triode-hexode (or mixing hexode) in which the part played by grid 1 and grid 4 are interchanged, so that it is possible to place the plate for the oscillator circuit outside the main electron stream. The control grid 1 receiving the signal surrounds the cathode and is itself enclosed by the first screen 2. The mixing grid 3, an extension of the oscillator grid comes next, it is separated from the plate by a second screen grid 4 connected internally with 2, so that the tube needs only 7 connections at the base and one for 1, at the top just as in the heptode. With this arrangement any increase in the control grid bias causes the plate current to drop without affecting the oscillator plate current. The conversion conductance is about 0.65 ma. per volt, and is at least as good as that obtained when two separate tubes are used.—Michel Adam, *Revue gen. El.* 36 (No. 21): 741-748. 1934. R. J. Wey, *Wireless Eng.* 11 (No. 135): 642-654. 1934. E. E. Shelton, *Wireless World* 35. (No. 14) 283-284. 1934.



Control of plate current by two grids

Bibliography of articles on super-regeneration

THE FOLLOWING list of articles on the subject of super-regeneration has been compiled by Gordon K. Burns and A. Gardner Fox, graduate students at the Massachusetts Institute of Technology. These men, under the direction of Dr. W. L. Barrow, are conducting a thesis investigation on super-regenerators, which has included a thorough examination of the existing literature. In view of the present interest in super-regenerative circuits, particularly for use on the ultra-high frequencies, it is believed that these references will be of great value to the radio engineer.

1. E. H. Armstrong, "Some Recent Developments of Regenerative Circuits," *I. R. E. Proc.*, Aug., 1922. First announcement of the principle of super-regeneration. Discussion of theory, oscillograms, and several circuits.

2. E. H. Armstrong, "La Superréaction," *L'Onde Électrique*, 1922, p. 625-637. Practically a translation of Armstrong's article in the *I. R. E. Proc.* (see No. 1).

3. L. Deloy, "Super-réaction," *L'Onde Électrique*, 1922, p. 544-548. Short summary of the basic principle.

4. G. J. Eltz, *The Armstrong Super-Regenerative Circuit*, New York, 1922. A pamphlet giving a great deal of practical constructional information on the circuits given by Armstrong (see No. 1), but rather barren of theoretical information.

5. E. O. Hulbert, *Proc. I. R. E.*, 1923, p. 391. A simple analysis showing that the amplification increases as the radio frequency is increased or the quenching frequency is decreased. Contains two simple circuits.

6. P. David, "Pratique de la Super-Réaction," *L'Onde Électrique*, 1923, p. 222-229. Practical notes on operation of a simple super-regenerative receiver. Theory not as well thought out as in his later articles.

7. E. V. Appleton, F. S. Thompson, "Periodic Trigger Reception," *I. E. E. Journal*, Feb., 1924, p. 187-191. Theory, experiments and discussion of a phenomenon related to, but not the same as, super-regeneration.

8. David, Dufour and Mesny, "Étude Oscillographique de la Super-Réaction," *L'Onde Électrique*, 1925, p. 175-200. Several good cathode-ray oscillograms. Analysis and discussion of some of the peculiarities of super-regenerative receivers.

9. M. G. Beauvais, "Émission et Réception par un Recepteur à Super-Réaction," *L'Onde Électrique*, 1928, p. 206-209. Mutual effects of two super-regenerative receivers tuned to the same frequency.

10. P. David, "Les Super-Réactions," *L'Onde Électrique*, 1928, p. 217-260. Very good article. Gives theoretical basis and experimental confirmation of three different types of super-regenerative action. Well illustrated with diagrams and oscillograms.

11. H. Kohn, "Uber die Pendelruckkopplung," *Zeit fur Hochfrequenztechnik*, Feb., 1931, p. 51-58; Mar., 1931, p. 98-105. Good article, based on both experimental and theoretical investigation. Deals with saturation of the vacuum-tube more adequately than earlier articles.

12. G. Gorelik, G. Hintz, "Uber die Wirkung des Pendelruckkopplers," *Zeit fur Hochfrequenztechnik*, Dec., 1931, p. 222-228. Includes treatment of the suppression of noise by a carrier signal, and multiple resonance peaks.

13. H. Barkhausen, *Elektronrohren*, Vol. I, 1931 ed., S. 136. (Book).

14. H. Barkhausen, *Elektronrohren*, Vol. II, 1933 ed., S. 64. (Book).

15. F. E. Terman, Sec. 68 of *Radio Engineering*, New York, 1932. Very brief summary of principle of super-regeneration. (Book).

16. G. Hassler, *Hochfrequenztechnik und Elektroakustik*, 1933, p. 42-44.

17. H. Barkhausen, G. Hassler, *Hochfrequenztechnik und Elektroakustik*, 1933, p. 41-42.

18. H. O. Roosenstein, "Uber fadingarme Demodulation und ihr Auftreten beim Superregenerativempfang," *Hochfrequenztechnik und Elektroakustik*, Sept., 1933, p. 85-89.

19. Calvin Hadlock, "Improving the 56-mc. Receiver," *QST*, May, 1933, p. 23-26. Practical refinements in super-regenerative receiver design.

20. "A Study of Super-Regeneration," *Electronics*, Feb., 1934, p. 42-44. Experimental and mathematical treatment of the idealized case of square-wave variation of resistance. No consideration of saturation of tube or multiple resonance peaks.

21. G. Hassler, "Grundsatze fur die Anwendung des Pendelruckkopplungs-Empfangers," *Hochfrequenztechnik und Elektroakustik*, Sept., 1934, p. 80-93. Very good article. Offers plausible explanations, supported in most cases by experimental evidence.

Television in Germany

[*Continued from page 11*]

used by the Telefunken company delivered much clearer pictures with greater brilliance.

The cathode-ray-tube receiver of the "Fernseh A.G." has a screen with dimensions 24x30 centimeters (9.4 by 11.8 inches), being the largest one available in Germany. The reproduction of this television receiver is generally praised as the best of all German receivers.

The television receiver of the "Radio A.G. D.S. Loewe" is also furnished with a cathode-ray tube. This receiver, with screen dimensions of only 10x15 centimeters (3.9 by 5.9 inches), is the cheapest one on the German market, selling for $220 to $270.

A very interesting television receiver is made by the Laboratory von Ardenne. The dimensions of the screen are 15x17 centimeters (5.9 by 6.7 inches); the color of the picture is light-green. The ultra-short-wave superhet used is worked without a second detector. The rectification of the i.f. impulses is done by the cathode-ray tube.

A very different type of television receivers is made by "The Tekade" Co. This receiver is furnished with a so-called "Spiegelschraube," or "mirror-screw" (a spindle with very small mirrors fixed upon the edge of the spindle). For illumination, a neon glow lamp is used, which is controlled by the television impulses obtained by the ultra-short-wave superhet receiver. The mirrors on the spindle reflect the light of the neon lamp, point after point, upon the rear of a semi-polished glass plate, having dimensions of 12x15 centimeters (4.7 by 5.9 inches). This kind of receiver is somewhat complicated because of its mechanically moving parts, but the reproduced pictures are of a very good quality, and in case of replacement only the cheap neon-glow lamp needs to be changed. There are some other very interesting television receivers upon the German market constructed for use in theaters, etc., the obtained pictures are about 10 by 13 feet and larger.

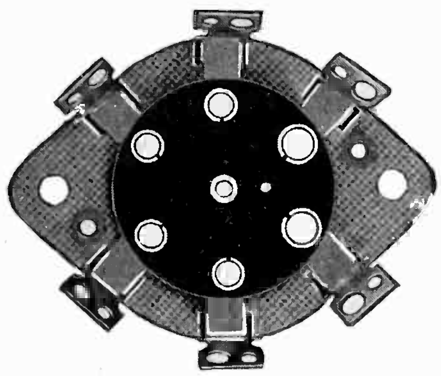
The German government in connection with the German radio industry is now working on a very interesting plan to sell these television receivers by means of an installment plan. The very successful experiment with the so-called "Folks-empfänger" (people's receiver) that had been sold during the season 1933-34 to the number of 500,000 radio sets of this kind, is evidence that co-operation between the government and the German radio industry in popularizing television in Germany is also likely to be successful.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Flush mounting socket

A NEW TYPE of flush mounting tube socket has been announced by A. W. Franklin Mfg. Corp., 137 Varick St., New York City. The design of the socket is intended to minimize noise due to poor contact and to prevent microphonic vibrations and speaker howl. To overcome the effect of poor connections, the contacts of the socket



are constructed of heavy brass, and completely encircle the tube prongs. The contacts have a decided taper so that the tube is held securely in place. A locking device is provided to prevent the contacts from spreading. An insulation ring is also provided as a recess for the shoulder of the tube prongs, so that the tube rests flush on the metal chassis, thus preventing vibration. The sockets are available in standard tube types with appropriate marks.—*Electronics.*

+

Single sideband signal generators

THE AUDIO-TONE OSCILLATOR COMPANY of Springfield, Massachusetts, has recently added to its line of inexpensive test units two r-f signal generators for precise receiver analyses.

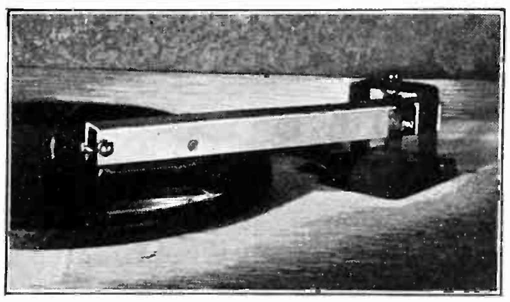
These signal generators are of the single sideband type, employing a balanced modulator-oscillator assembly. This feature makes them particularly useful for the determination of receiver selectivity and sideband fidelity. They offer a calibrated audio frequency modulation range of 20 to 10,000 cycles and single sideband modulation calibration from 10,000 cycles lower sideband to 10,000 cycles upper sideband. This modulation is available to 100% with double sideband modulation optional for square law detector analysis.

The Audio-Tone single sideband signal generators cover the usual I.F.-R.F. frequency range 100 K.C. to 1,700 K.C., this range being made available by means of plug-in inductors for the precision model and a coil change switch for the service unit.—*Electronics.*

+

Crystal pick-up

A NEW crystal phonograph pick-up is announced by the Ansley Radio Corporation, 240 W. 23rd Street, New York, who are using it on their radio-dynaphone combinations. In addition to the light weight and high fidelity, characteristic of crystal pick-ups, the manufacturer claims other advantages. Built-in sponge rubber suspension insulates the pick-up from speaker and motor vibration, and a "vertical pivot-



ing" arrangement reduces friction to a minimum. While it was developed primarily for use in the Ansley dynaphones and combinations, the pick-up is also being sold separately to dealers and distributors.—*Electronics.*

+

Small heavy-duty resistors

PYROHM Junior wire-wound vitreous enamel resistors developed by Aerovox engineers are now available in 10, 15 and 20 watt ratings, and 100-30,000, 250-70,000, and 1000-100,000 ohms. The units are wound on a porcelain tube with a special high grade resistance wire, the ends of which are brazed to copper bands, while the pigtail leads are soldered to the terminal bands. The entire unit is completely coated with a vitreous porcelain enamel, thoroughly protecting the winding against moisture and mechanical injury. The units are being produced by the Aerovox Corporation, Brooklyn, N. Y.—*Electronics.*

Universal sealing machines

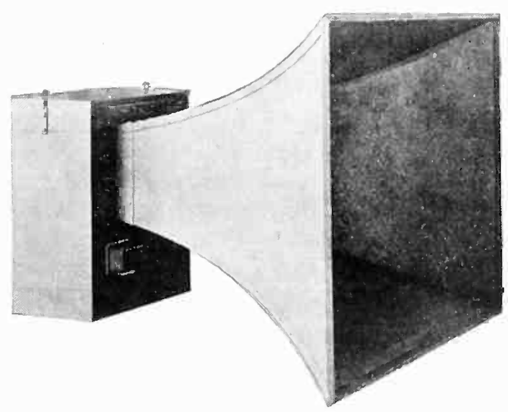
TWO STYLES of sealing machines are offered by the Eisler Engineering Co. These machines, known as butt sealing machines, are made in two styles, vertical and horizontal. Regardless of the type of tube to be handled, the machines are sufficiently flexible in operation to take the work. They are universally adaptable for sealing electron tubes.

An improved grid and resistance wire winding machine is introduced by this company also. In making grids on this machine, the wire is imbedded so that it cannot move and thus produce short circuits. Machines for winding in continuous lengths on round asbestos are also available.—*Electronics.*

+

Sound projectors

IN ITS NEW Jensen Peri-dynamic projectors, the Jensen Radio Manufacturing Company, 6601 South Laramie Avenue, Chicago, has combined a number of features important for public-address work as follows: The speaker is enclosed in an air-tight and weather-proof enclosure free of resonance; improved performance on both voice and music; high efficiency and no power loss through back side radiation; reliability, life measured in years; no back side radiation



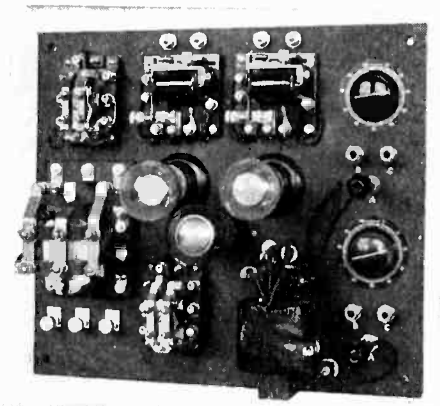
toward microphone; same models suitable for outdoor and indoor operation.

The most radical departure from general practice is the sealing of the speaker itself into the air-tight container. The speaker is completely enclosed except where it opens into the horn, and there the moving-coil opening is closed and made as waterproof as possible.—*Electronics.*

Electronic timer

For sign flashers, test equipment, and other "on" and "off" applications, in connection with a wide variety of electrically-operated devices and machines requiring automatic timing, the Electric Controller & Mfg. Company, Station C, Cleveland, Ohio, announce their new automatic repeat-process timer.

This timer is built in four standard sizes and is designed for operation on 110, 220, 440 or 550 volt circuits of any standard frequency. Operating on the principle of the time required to charge a condenser, it provides a quick, convenient means for closing an electrical



circuit for a definite length of time, and then opening the circuit for a similar, or different time, as desired, and repeating this cycle of operation as long as the control push button or master is closed. Both the "power-on" and the "power-off" periods are independently adjustable to give the time desired.

The "power-on" period can be adjusted from .05 seconds minimum to .90 seconds maximum on the smallest size of timer. The "power-off" period of this same size timer is adjustable over a similar range of time. With both periods set at minimum time, the timer will provide 550 operations per minute.

The illustration shows this timer with its two independent adjusting dials for each circuit. The timer as shown has been removed from its enclosing cabinet in which are also mounted small condensers for both the "on" period and the "off" periods. Complete timers are shipped with these condensers properly wired to the correct terminals.—*Electronics.*

✦

Intermediate wave radio transmitter

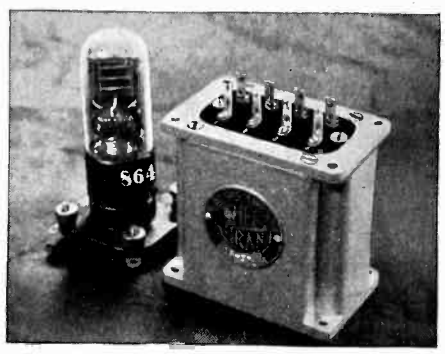
Radiomarine Corporation of America, 17 Varick Street, New York announces a radiotelegraph transmitter (Type ET-8003) for use on shipboard. The transmitter operates on the range of 800 to 600 meters (375 to 500 k.c.), delivers 25 to 50 watts to the antenna, and can operate either from the 110 volt d-c mains of the ship, or as an emergency transmitter from the 12-volt battery furnished with the installation. The transmitter uses 4 type 10 tubes, and has a daylight range of several hundred miles under usual conditions. Its range can be greatly increased by the use of a high-frequency unit which uses the same power supply. — *Electronics.*

✦

Miniature audio transformers

A new standard line of high-quality miniature audio transformers has been announced by the American Transformer Company, Newark, New Jersey. These units have frequency characteristics uniform within plus or minus one db from 30 to 12,000 cycles and are intended for use in portable amplifiers.

An important advantage claimed for Amertran miniature de luxe transformers is that they are self shielded both electro-magnetically and electrostatically through special construction rather than with heavy cast iron mountings. A new catalog, No. 1002, describes these units and is available on request.



The Amertran miniature de luxe line is furnished in light weight aluminum mountings requiring only $5\frac{1}{2}$ square inches mounting space as compared with approximately 10 square inches for a standard shielded transformer. The line includes 15 standard designs.—*Electronics.*

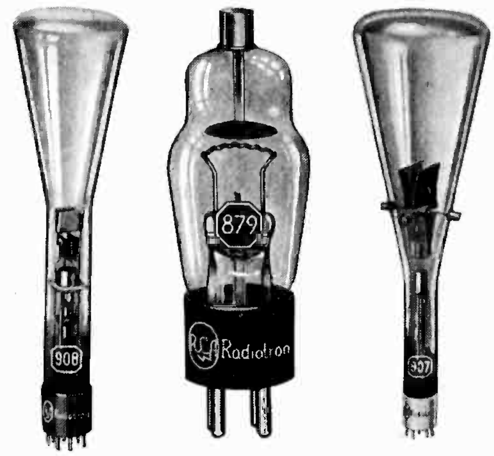
✦

Rectifier tube for battery charging

A six ampere rectifier for use in battery charging installations is offered for sale by the National Union Radio Corp., 400 Madison Ave., New York City. The filament draws approximately 18 amperes at two volts, while the filament-to-plate current-carrying capacity is six amperes. Advantages claimed for the tube are high operating efficiency and ability to stand temporary overloads without loss of life. The tube is designed to replace any standard rectifier tube of its capacity.—*Electronics.*

Radiotrons 907, 908 and 879

Three new types of radiotrons are announced by the RCA Radiotron Company, Inc., Harrison, N. J. The RCA-907 and RCA-908 are two new cathode-ray tubes and the RCA-879 is a high voltage rectifier. The 907 and 908 cathode-ray tubes are of the hot-cathode, high-vacuum, electrostatic type, and employ a viewing screen material especially suited for recording on motion film and



for rotating-mirror timing methods. The screen material has a persistence of phosphorescence of less than 25 microseconds. The 907 has a 5-in. diameter screen, while the 908 has a 3-in. diameter screen. The 879 high-vacuum rectifier tube is particularly designed to supply the d.c. voltage required by cathode-ray tubes. The electrical and physical characteristics of these tubes are given in pamphlets available from the RCA Radiotron Company.—*Electronics.*

✦

Interference-free line insulator

The radio interference problem presented by pin-type insulators has produced an extremely difficult problem for electric-utility engineers. Recognizing this, the Lapp Insulator Company, Le Roy, N. Y., has developed an entirely new type of insulator which from tests in the laboratory and in practice seems to do away entirely with radio interference. This Lapp "line post" is of vacuum-process porcelain, and withstands stones and bullets, puncturing or cracking, and power arc-overs. It is designed primarily for the lower-voltage transmission lines, and the manufacturer advises: "Sound future planning demands that all insulators purchased, whether for maintenance or new construction, be of the radio-free type."—*Electronics.*

50-watt power pentode type RK-20

A RADIO frequency power pentode designed for use as a suppressor grid oscillator, power amplifier, or modulator has been developed by the Raytheon Production Corp., Newton, Mass. The tube, known as the RK-20, serves a need not filled by other commercially available tubes; 50 watts of RF power can be taken from the plate load circuit without difficulty even when operating as a crystal oscillator. When used as an oscillator and RF power amplifier, the maximum plate dissipation power is 35 watts. The filament operates on 7.5 volts a.c., the plate potential is 1,250 volts, the screen grid 300 volts, the control grid minus 75 volts, at which values it will deliver an output of 50 watts. The tube is $8\frac{3}{4}$ in. in total height by $2\frac{1}{16}$ in. maximum diameter. The plate lead is led out to the top of the tube, while a 5-prong base provides the other connections. When used as a suppressor grid modulator, 100 per cent modulation can be effected with an excitation of less than 1 watt of audio power.—*Electronics.*

✦

Uniform current volume control

A NEW TYPE of volume control which provides a uniform current distribution throughout the entire resistance element is announced by Electrad, Inc., 175 Varick St., New York, N. Y. The resistance element is highly resistant to wear and humidity and is applied on the outside of a sturdy molded Bakelite ring. All of the electrical contacts in the control are of silver and the element is self-cleaning. Provision is made for attaching a power switch without disconnecting the terminals. The unit measures $1\frac{7}{16}$ in. in diameter.—*Electronics.*

✦

High frequency crystal speaker

A NEW HIGH frequency speaker using a rochelle salt crystal as the motor has been designed by the Brush Development Co., E. 40th & Perkins Ave., Cleveland, Ohio. The speaker type T-51 has been designed to furnish comparatively inexpensive units for use of radio receiver and public address equipment manufacturers. The units are of high efficiency, so that it is generally necessary to reduce the voltage of the output of the receiver applied to the high frequency unit. Since the speaker has a negative reactance no filter is required when the speaker is combined with an inductive low frequency reproducer of the usual moving coil type. The speaker is approximately 5 in. in diameter and 2 in. deep. The list price of the T-51 is $7.—*Electronics.*

✦

Multi-range a-c, d-c meter

THE TRIUMPH MANUFACTURING CO., 4017 West Lake St., Chicago, Ill., is manufacturing a multi-range meter, model 300. This meter will read a.c. and d.c. voltage up to 1,000 volts, the a.c. scale being separately calibrated. By using an external battery resistance values from $\frac{1}{2}$ ohm to 10 megohms may be read. The meter movement is of

the D'Arsonval type. A lance type pointer for easy reading is provided. The self-contained battery has a very long life, the battery life being about equal to the shelf life. The price of the model 300 meter is $19.95 net.—*Electronics.*

✦

Ultra-high frequency antennas

Four types of antennas for use on 5 and 2.5 meters are offered for sale by Arthur H. Lynch, Inc., 227 Fulton St., New York, N. Y. Types L 42 and L 43 are quarter-wave antennas for use on automobiles and list at $3.50 and $4.00 respectively. Types L 24 and L 26 are intended for use on aircraft or ground stations. They provide one-half wave sections and list at $7 and $7.50 respectively. The terminal impedance of the above antennas is approximately 70 ohms. Aircraft duralumin tubing telescoped together in from two to six sections is used.—*Electronics.*

Relay-control resistors

THE USE of resistors as relay controls is advocated by the Ohmite Manufacturing Company, 636 North Albany Avenue, Chicago, Ill. The Dividohm semi-variable, vitreous enameled resistor can be attached to a standard relay rack and the current required to operate the relay regulated from the control circuit. The resistors are used either in shunt or in series. The Dividohm is a resistor fitted with a movable sleeve which makes contact with the resistance wire and which can be moved to provide different resistance values.—*Electronics.*

✦

Rectifiers

THE RAYTHEON MANUFACTURING COMPANY, 190 Willow Street, Waltham, Mass., announces that it has acquired from the Square D Company of Detroit, the latter's "RectiFilteR" business. These units will henceforth be manufactured at Waltham, Mass.

RectiFilteRs are devices for changing A.C to D.C., the conversion being effected with no moving parts. They consist of transformers, rectifying elements, choke coils, and condensers. In some cases meters, relays, switches, and other control equipment are included. RectiFilteRs are designed for operation from any A.C. power circuit and by appropriate design of the transformers and rectifying elements can be made to deliver D.C. at almost any combination of voltage and current. The residual A.C. component remaining in the D.C. output can be reduced to any desired degree by the proper selection of choke coils and condensers. Both copper oxide and bulb rectifiers are employed, depending upon the rating.

The Raytheon line includes standard unit for broadcasting, theatre, fire alarm, signal, telephone, and battery charging service. Among the various sizes are low-voltage units rated at a few milliamperes to over 20 amperes, and others delivering as much as 12,000 volts at 2 amperes.—*Electronics.*

✦

Dynamic microphone

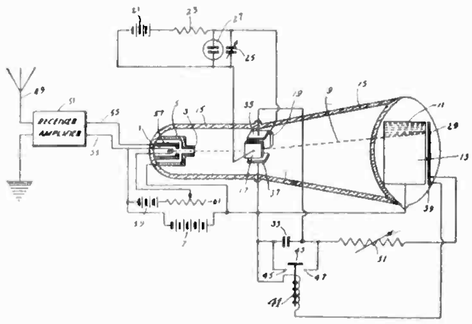
THE AUDIO RESEARCH CORPORATION, 105 East Sixteenth Street, New York City, has brought out a new dynamic microphone which requires no pre-amplifier. The new unit is impervious to moisture, temperature and shock, and is declared to show a flat curve from 60 to 9000 cycles. Special construction features in this new Audio microphone contribute to its simplicity of design and operation, resulting in low cost.—*Electronics.*

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Television and facsimile

Multi-channel receiver. A system for receiving the horizontal and vertical scanning signals, the picture signal circuit, etc. W. L. Carlson, R.C.A. No. 1,975,956. See also 1,975,055, J. Weinberger and George Rodwin, R.C.A.

Scanning system. A cathode ray circuit. W. Ilberg, Telefunken. No. 1,976,400. See also H. J. McCreary, Asso-



ciated Electric Laboratories, No. 1,978,684.

Facsimile system. Patents No. 1,973,725 and 1,973,726 to R. H. Ranger, R.C.A. on facsimile transmission system.

Electrooptical image production. No. 1,971,674 to J. H. Bollman, B.T.L., and 1,971,675 to J. W. Horton, B.T.L.

Radio circuits

Field strength meter. A loop set with means for inserting a known resistance in series with loop to be traversed by the resonance current. P. B. Taylor, WE&M Co. No. 1,982,331.

Modulation meter. Means for indicating the ratio of the peak value of audio frequency component to direct current component in a rectifier. James D. Booth, WE&M Co. No. 1,979,669.

Transmission circuit. Use of a reactance voltage divider. P. O. Farnham, R.F.L. No. 1,978,255.

Automatic volume control. Roger Aubert, Paris, France. No. 1,978,184; Karl Wilhelm, Siemens & Halske. No. 1,978,182. Wilhelm Runge, Telefunken. No. 1,978,552.

Coupling circuit. Interstage circuit and a reactive coupling common to several circuits, its reaction being resonant to a frequency close to the lowest frequency to which each of the circuits is resonated. W. D. Loughlin and C. J. Franks, R.C.A. No. 1,978,212.

Network. A high frequency network having a logarithmic rectifier characteristic. H. O. Roosenstein, Telefunken. No. 1,978,478.

Altimeter. A super high frequency impulse system. A. H. Taylor, L. C. Young and L. A. Hyland, Washington, D. C. No. 1,979,297.

Remote control system. A motor type of apparatus for tuning a receiver from a distance. F. K. Vreeland, Montclair, N. J. July 24, 1929. No. 1,979,588.

Remote speaker. A circuit for using one or two dynamic types of loud speakers, one of which is remote from the receiver proper. W. J. Schnell, Electrical Research Laboratories, Inc. No. 1,982,965.

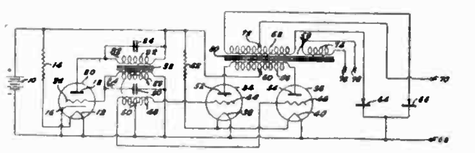
Static reducer. In series with the antenna-ground and set input is a parallel resonance circuit, tuned to the signal frequency so as to prevent the main antenna circuit being materially knocked into oscillation at signal frequency, and so that impulse currents set up in the main antenna will have wave forms corresponding to those of the disturbing impulses and will be at frequencies other than that of the desired signal, thereby effecting an attenuation of the impulse currents. David M. Crawford, Mifflintown, Pa. No. 1,968,817.

Antenna system. Multiplex antenna systems in which a down lead is properly matched to several receivers. E. V. Amy and J. G. Aceves, Amy, Aceves & King. Nos. 1,976,909 and 1,976,910.

Amplification, detection, etc.

Positive bias amplifier. A two-tube system described in *Electronics*, June, 1930, by Lincoln Thompson, R.C.A. No. 1,983,714.

Converter. An electrical network for changing low voltage d-c into high volt-



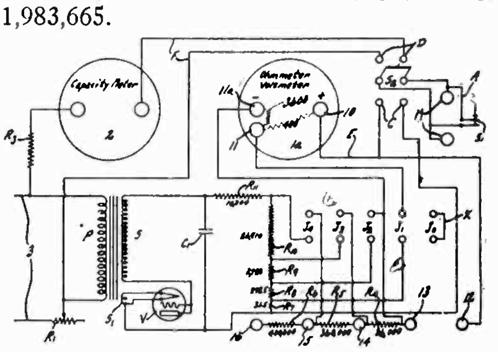
age d-c by means of an electronic tube oscillation generator. Henry Tholstrup, R.C.A. No. 1,979,422.

Oscillator. A stable frequency oscillator. F. B. Llewellyn, W-E Co. No. 1,976,570.

Broad band amplifier. In the plate circuit of a tube are two transformers, each of which covers a broad band of frequencies. G. S. C. Lucas, G-E Co. No. 1,976,504.

Screen grid circuits. For use in ultra high frequency circuits. A capacity bridge between the anode and output circuit. Werner Buschbeck, Telefunken. No. 1,974,912.

Measuring instrument. Device for testing condensers, comprising a tube, a rectifier, etc. R. D. Hickok. No. 1,983,665.

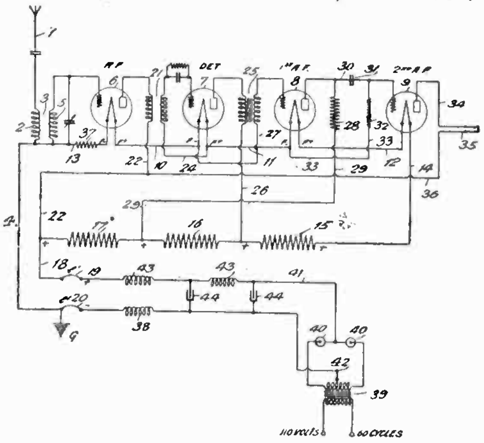


Frequency multiplier. Wilhelm Kummerer, Telefunken. No. 1,982,916.

Short wave oscillation generator. E. W. B. Gill, R.C.A. No. 1,983,848.

Tuning system. In a high-frequency amplifier, the tuning of the anode circuit is effected by moving non-metallic magnetic cores with respect to inductances. L. H. Lynn, G. E. Co. No. 1,983,380.

Current amplifier. A series filament arrangement with a single source for producing bias for each tube, anode volt-



age, etc. J. G. Aceves, R.C.A. 13 claims, applied for Aug. 13, 1924. No. 1,982,777.

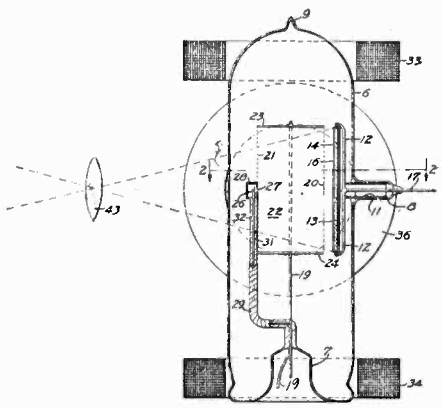
Modulating system. A polyphase frequency converter and modulator of the cathode ray type. R. M. Heintz, assigned to Heintz & Kaufman, Ltd. No. 1,983,172.

Core material. Patents on "poly" iron. No. 1,982,689, 79 claims filed March 16, 1931, and 1,982,690, 40 claims, Aug. 26, 1929. W. J. Polydoroff, Johnson Laboratories.

Electron tubes

Autoelectronic device. A cold cathode tube. J. E. Lilienfeld, Brooklyn, N. Y. No. 1,979,275.

Photo tube. An anode permeable to light and a photo-sensitive cathode and an auxiliary cathode having all but a



small area shielded from the cathode and positioned to receive a pre-determined portion of the discharge therefrom. P. T. Farnsworth, Television Laboratories, Inc. No. 1,979,036. See also 1,975,143 to Farnsworth on three-grid thermionic tube.

Discharge tube. Patents Nos. 1,973,075 and 1,968,770. August Hund, Wired Radio, on space discharge tubes and their use. See also 1,972,647 to Philips on cold cathode tubes.

Mercury arc tube. A grid-controlled tube with a shield spaced from the cathode by a small distance and means for controlling the potential of the shield with respect to the cathode. L. R. Ludwig, WE&M Co. No. 1,975,164.

Electron tube applications

Stroboscope. A circuit of the grid-glow type. D. D. Knowles, WE&M Co. No. 1,979,692.

Reflectometer. An integrating sphere with an aperture to be covered by a test surface. F. A. Benford, G.E. Co. No. 1,979,952.

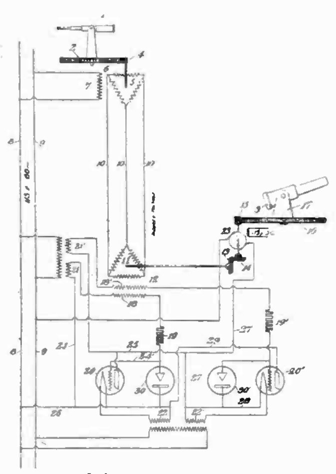
Ear exercising device. Device for creating audible vibrations for measuring the hearing range of the ear. Also a device for producing a constant tone, thermostatic means for automatically varying the frequency of the tone, and means for amplifying the tone and for feeding it to a human ear. J. P. Davenport, Detroit, Mich. No. 1,983,737.

Exposure meter. Photoelectric circuit including a means for measuring the variable resistance produced by light variations. G. G. Moreno, Moreno-Snyder Cine Corp. No. 1,980,217.

Exposure meter. A current generating photoelectric cell. H. F. Tonnies. No. 1,982,406.

Control circuit. Circuit of the type using a rectifier and a saturated-core reactor. F. G. Logan, Ward Leonard Electric Co. No. 1,977,193, 1,981,921 and 1,982,007.

Position and distance measurement and control. Apparatus for gaging depth, distances, altitude, etc. No. 1,-977,772, J. E. Miller, Detroit, Mich. No. 1,977,875, C. A. Donaldson, San Antonio, Texas. No. 1,979,225, R. W. Hart, Submarine Signal Co., Boston, Mass. No. 1,977,624, to A. P. Davis, Arma Engineering Co., and No. 1,983,-254, to E. E. Turner, Submarine Signal Co., Boston.



No. 1,977,624

Relay circuits. The following patents relate to various types of relays of the thermionic and photoelectric tube type: No. 1,973,286, to D. D. Knowles, WE&M Co., electric-discharge type. No. 1,977,353, to L. R. Quarles, WE&M Co., two tube relay. No. 1,-980,146, time switch device to A. W. Vingerhoets, Philips. Glow relay system. H. C. Rentschler, Westinghouse Lamp Co. No. 1,982,829, No. 1,979,314 to L. F. Curtis, United American Bosch on a thermionic relay for using a-c circuit having one side grounded.

Counting microscopic bodies. A method for investigation of solutions and suspensions, for example, in the analysis of blood by photoelectric means. Frank Twyman and D. H. Follett, Adam Hilger, Ltd. No. 1,974,522.

Patent Suits

1,141,402, R. D. Mershon, Electrolytic apparatus employing filmed electrodes; 1,784,674, same, Film formation and operation of electrolytic condensers and other apparatus, C. C. A., 2d Cir., Doc. 13321, R. D. Mershon et al. v. J. F. O'Neill et al. Decree reversed.

1,231,764 (a), F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,403,932, R. H. Wilson, Electron discharge device; 1,702,833, W. S. Lemmon, Electrical condenser; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed Apr. 23, 1934, D. C., N. D. Ill., E. Div., Doc. 13842, Radio Corp. of America et al. v. S. P. Zaney et al. Doc. 13844, Radio Corp. of America et al. v. D. Coombs. Doc. 13846, Radio Corp. of America et al. v. M. H. Hoffman et al.

1,231,764 (b), F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,702,833, W. S. Lemmon, Electrical condenser; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed June 28, 1934, D. C., E. D. Mich. (Detroit), Doc. 6443, Radio Corp. of America et al. v. General Television.

1,251,377 (a), A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents 1,573,374, P. A. Chamberlain, Radio condenser; 1,728,879, Rice & Kellogg, Amplifying system, filed Apr. 23, 1934, D. C., N. D. Ill., E. Div., Doc. 13843, Radio Corp. of America et al. v. S. P. Zaney et al. Doc. 13845, Radio Corp. of America et al. v. Danco, Inc., et al. Doc. 13847, Radio Corp. of America et al. v. M. H. Hoffman et al.

1,251,377 (b), A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,273,627, I. Langmuir, Method of and means for controlling electric currents or potentials; 1,297,188, 1,313,094, same, System for amplifying variable currents; 1,631,646, C. W. Rice, Sound reproducing apparatus; 1,707,617, 1,795,214, E. W. Kellogg, same; 1,899,561, H. G. Dorsey, Telephone receiver, filed May 5, 1934, D. C., N. D. Ill., E. Div., Doc. 13873, Radio Corp. of America et al. v. Enterprise Optical Mfg. Co.

1,251,377 (c), A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,707,617, 1,795,214 E. W. Kellogg, Sound reproducing apparatus; 1,728,879, Rice & Kellogg, Amplifying system, filed June 28, 1934, D. C., E. D. Mich. (Detroit), Doc. 6442, Radio Corp. of America et al. v. General Television Co. et al.

1,545,207, 1,617,179, 1,617,180, C. G. Smith, Electrical apparatus; 1,617,171, same, Method and apparatus for the rectification of alternating currents; 1,-617,172, 1,617,177, same, Production of electrical variations; 1,617,174, same, Electrical apparatus and method; 1,617,-178, 1,617,181, V. Bush, Electrical apparatus; T. M. 208,886, American Appliance Co., Rectifier tube; T. M. 237,111, Raytheon Mfg. Co., Rectifying, regulating and smoothing tubes and battery eliminators; T. M. 266,330, Raytheon Production Corp., Vacuum tubes, valves, etc., D. C., Mass., Doc. E 3419, Raytheon, Inc. of Cambridge, et al. v. Selection Corp. et al. Consent decree for plaintiff for an injunction against Selectron Corp., Terkelson and A. L. Hanson July 13, 1931. Decree pro confesso as against Phair, Weeden & Magerer. Dismissed as to Beckwith, Rich & Waldstein without prejudice for lack of prosecution Jan. 2, 1934.

1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,403,932, R. H. Wilson, Electron discharge device; 1,702,833, W. S. Lemmon, Electrical condenser; 1,618,-017, F. Lowenstein, Wireless telegraph apparatus; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,-579, Ballantine & Hull, Demodulator and method of demodulation, filed June 27, 1934, D. C., N. D. Ill., E. Div., Doc. 13957, Radio Corp. of America et al. v. Climax Radio Corp. et al.

1,231,764, F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,702,833, W. S. Lemmon, Electrical condenser; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, D. C., E. D. Mich. (Detroit), Doc. 6443, Radio Corp. of America et al. v. General Television, Inc., et al. Consent decree for plaintiff (notice July 11, 1934).

1,244,217, I. Langmuir, Electron discharge apparatus and method of operating same; Re. 15,278, same, Electron discharge apparatus; 1,374,679, J. B. Pratt, Degasifying process; 1,718,206, I. E. Mouromtseff, Vacuum tube; 1,852,-865, C. B. Upp, Carbonized non-emissive electrode; 1,865,449, J. L. Wuertz, Thermionically inactive electrode; 1,879,-514, Round & Picken, Means for supporting the electrodes of thermionic devices; 1,880,937, H. M. Elsey, Process of carbonizing nickel or other metals; 1,893,-466, R. F. Gowen, Audion construction; Des. 76,947, F. T. May, Electron emission device, filed June 29, 1934, D. C., N. D. Ill., E. Div., Doc. 13965, Radio Corp. of America et al. v. F. J. Hajek (Taylor Tubes) et al.

1,251,377 (a), A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,707,617, 1,795,214, E. W. Kellogg, Sound reproducing apparatus; 1,728,879, Rice & Kellogg, Amplifying system; 1,894,197, same, Sound reproducing apparatus, filed June 27, 1934, D. C., N. D. Ill., E. Div., Doc. 13958, Radio Corp. of America et al. v. Climax Radio Corp. et al.

1,251,377 (b), A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,707,617, 1,795,214, E. W. Kellogg, Sound reproducing apparatus; 1,728,879, Rice & Kellogg, Amplifying system, D. C., E. D. Mich. (Detroit), Doc. 6442, Radio Corp. of America et al. v. General Television Co. et al. Consent decree for plaintiffs.

BRITISH PATENTS

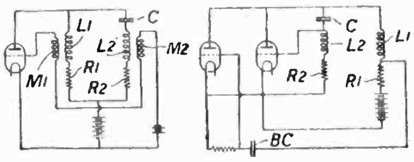
British patents are important to American readers because these disclosures often forecast corresponding U. S. patents which may not be issued until a year later.

Radio receiver circuits

Interstage coupling. The use of a resistance material, the resistance of which is proportional to $CI - a$ (where I is the current and C and a are constants), for example, the material Thyrite. The material is used to compensate for the curvature of tube characteristics. I. Wolff, Marconi. No. 414,251.

Heterodyne receiver. The input LC circuit of a receiver has its damping varied periodically and is followed by a detector which produces a higher harmonic of the damping frequency. This harmonic is amplified and detected to produce the signal. Philips. No. 414,266.

Oscillation stabilizer. A voltage derived partly from one branch and partly from another branch of the resonant anode circuit of an oscillator is fed back



to the grid with the object of preserving strict anti-phase between the anode and grid voltages. Marconi Co., E. B. Moullin. No. 415,716.

Noise suppressor system. In the absence of signals an amplifier is disabled by the application of grid bias and a single connection thereto from the detector applies the low frequency signal voltage and a bias releasing voltage when a signal is received. A. L. M. Sowerby and Cossor, Ltd. No. 415,729.

Super-regenerator. A receiver capable of operating either as a circuit of high sensitivity without great selectivity or as a circuit of high selectivity. Means are provided so that effecting the change-over will not change the tuning of the receiver. Marconi Co. No. 416,047.

Gain control. Amplifier gain is adjusted by varying the negative bias on a control grid interposed between two positively-charged electrodes which may comprise grid electrodes or a grid and anode. The negative bias may be adjusted by hand or automatically by a rectified carrier wave. The arrangement minimizes cross modulation and distortion. E. Y. Robinson, Associated Electrical Industries, Ltd. No. 408,256.

High frequency amplifier. A grid leak detector in which, to prevent lowering the impedance of the circuit, the resistance across the condenser connects through a portion of the coil. Philips. No. 412,532.

Push-pull circuit. Two tubes operating at the bottom bend of their characteristics, and have the input voltage divided between them proportionately to the inverse of the ratio of their mutual conductances by having across the secondary windings resistances into which the grids are tapped by variable leads. Standard Radio Relay Services. No. 412,678.

Superheterodyne circuit. Use of a diode-pentode tube as a combined local oscillator, first detector and intermediate frequency amplifier. Ferranti, Ltd. No. 412,693.

Gain control. In a thermionic amplifier a means for abruptly altering the gain and means for cancelling out transient impulses due to said abrupt gain change. Marconi Co. No. 415,619.

Dynatron circuit. The output amplitude of a dynatron amplifier combination, or a beat-frequency generator, including a dynatron oscillator as one element, is stabilized by rectifying the output voltage and applying the resulting d-c voltage to an auxiliary electrode in the dynatron to adjust its negative resistance. Marconi Co. No. 415,142.

Diode detector. In a diode-triode the diode is connected to counteract the second harmonic distortion produced by the amplifier due to the positive half waves being amplified more than the

FIG.1.

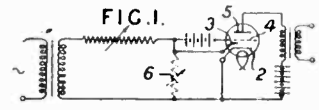
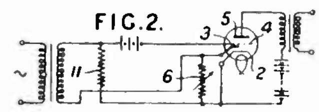


FIG.2.



negative half waves. G.E. Co. No. 414,359.

Noise suppressor. The delay voltage of a muting device is increased automatically with increases in signal strength to render the sharpness of muting more nearly independent of signal strength. G. E. Co. No. 414,474.

Attenuation system. A low-frequency amplifier is provided with a coupling in which the attenuation characteristic can be varied for accentuating the higher voice frequencies or for other purposes, and provision is made for filtering out a heterodyne whistle or similar noises. E&M Industries, Ld. No. 414,651.

Landing beam. Instead of landing along a line of constant field strength,

FIG.4.

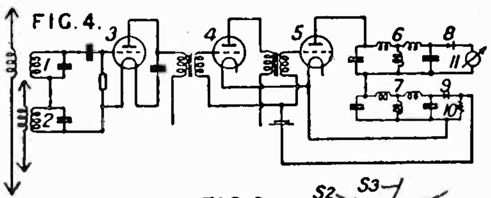
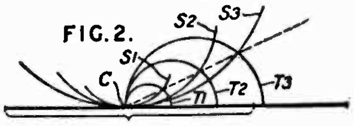


FIG.2.



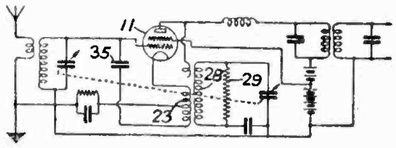
the pilot flies along a line representing a constant ratio of two signals. Telefunken. No. 416,246.

Multi-band receivers. Several circuits for facilitating wave-band switching and the use of a tuning-condenser marked with an exact frequency-scale. Radioakt.-Ges. D. S. Loewe and K. Schlesinger, Berlin. No. 414,836.

Superheterodyne. The frequency of the local oscillator is controlled by a harmonic of the intermediate frequency. E&M Industries, Ltd. No. 415,051.

Superheterodyne. In a supersonic receiver gain control is accomplished by controlling the frequency of the local oscillator in dependence on received signal strength. Marconi Co. No. 415,060.

Oscillator modulator. Neutralization of the inherent grid-cathode capacity in an oscillator-modulator suitable for use as a frequency-changer and to produce

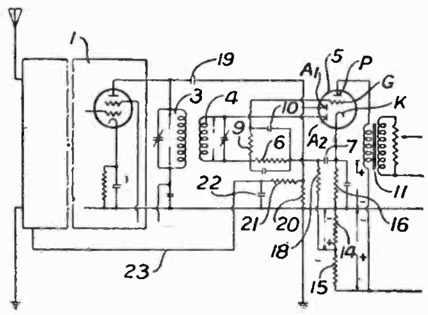


local oscillations of constant amplitude over the tuning range. V. E. Whitman, Hazeltine Corp. No. 415,504.

Image suppressor. In a superheterodyne receiver the inductance in a high-frequency tuning circuit is divided into two parts, one of which is placed in series with a variable condenser and shunted across the other portion of the inductance. The condenser inductance circuits form a short circuit for the image frequency. Philips. No. 415,017.

Gang tuning. The effect of changes in grid-bias, due to AVC upon the tuning of ganged amplifiers is neutralized by the insertion of a coupling-resistance common to both the grid-cathode and anode-cathode circuits. The impedance of this insertion has the same frequency characteristic as the inter-electrode tube capacity between grid and filament, but is of opposite phase. Philips. No. 415,009.

AVC system. The bias voltage applied to a rectifier forming part of an AVC system renders said rectifiers inoperative for input voltages below a certain value and is automatically reduced



by means responsive to the rectified output, when input voltages above the determined value are rectified. P. O. Farnham, R.F.L. No. 415,598.

Automatic volume control. The potential drop across an element of a filter is used for supplying anode and grid potentials to a tube used as A.V.C. K. A. Chittick, Marconi Co. No. 416,176.

Directional reception. Operating solely on the ground wave to the exclusion of the sky-wave when determining direction. Repeated impulses are transmitted for periods of one five-thousandth second separated by intervals sufficient to allow each signal and its reflected counterparts to be received before the arrival of the next signal. E. V. Appleton. No. 416,126.